Material Handling and Storage in Steel Industry A Qualitative Study

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Abstract: Manual Material Handling (MMH) has largely been a burning case in various types of industries including process and various other manufacturing industries. Generally ergonomic issues are a major concern in these types of industries where the job is broken down into various parts and sub parts. As men use to depend on machine even for small work i.e. increasing the men-machine interaction as a result the challenge in classifying material manual handling arises. This paper will basically focus on the major hazards that are generally faced by a worker in his day to day life in an organization and also the mitigating measures in order to decrease the risk evolved from the hazards. The main context of my study is based on a steel manufacturing plant. The various statistics regarding the workers working hours and injury as per the age group has been cited in the tabulated form below. In the latter part of our discussion the inspection and maintenance of various work equipment's have been discussed. Finally, this qualitative report will help us to eliminate the various challenges that are been faced by employee in their daily workplace.

Index Terms **- Musculoskeletal injuries, Ergonomic problem, Back belts, Conveyor safety.**

I. INTRODUCTION

The movement and transferring of goods and products inside and outside of an industry is one of the most important sources of revenue for an organization. The purpose of loading and unloading product from trucks, trailers, and railroad cars is essential to production. Product arrives at store yard, and is unloaded, and then placed in storage. At a later time the product is collected by workers for transferring and carrying to different sections of the plant. Without the movement of product very little would be accomplished in industry. This movement and transferring of product and goods is a contributor to many workplace injuries [3].This report will focus on the manual handling of product and the use of back belts, conveyor safety, people who and how is affected and about the inspection and maintenance of various equipment.

It is due of the bigger size, bulky weight and deviation on the shape of most metal stock, manual material handling will culminate to the risk of various ergonomic problems and musculoskeletal disorder (MSD) [4].Recent study made by industry suggest that almost majority of the accidents happen due to steel stockholding as a result of material handling operations. Hence, it must be planned, designed and installed for eliminating the high-risk of material handling during Transport, storage and handling systems.

Musculoskeletal injury from metal stock handling is most likely to be caused by greater or higher force applied to withdraw the stock, higher levels of material handling tasks, excessive bending, stretching or reaching far, incorrect posture of working. [5]

In spite of that, many examples of significant risk like crushing (primarily fingers, hands and feet), or other injury, caused by sudden movement of goods or stock in material handling

II. METHODOLOGY

The raw materials that are generally used for manufacture of steel components and iron ore are dolomite, hematite, limestone etc. These materials are supplied by outside agencies to the plant/industries for carrying out the production [6].

As the raw materials are brought inside the premises with the help of trolley mounted trains filled with each bogies, many material handling equipment are used to empty the bogies, one of them is the wagon tippler, it completely lift up the boggy to an angle of 2700c, and then the raw materials are passed through mesh having size of 60 mm.The particle size having less than 60 mm is been passed through the mesh and a heap of raw material is formed in the storage yard.

The height of the heap of the raw materials must not be more than 4.5m and proper storage facilities must be maintained in the yard. As the steel power plants are located in hot and humid conditions, so there might be chances of attaining the auto ignition temperature of the material being stored. Hence, provision for sprinkler system along with fire hydrant, monitors and extinguishers must be provided in the storage area.

The transport of raw material is being done by two huge equipment known as stacker reclaimer and barrel reclaimer. Stacker reclaimer is generally preferred for larger or huge heap of materials. It generally consists of a big wheel in which buckets are attached outside the periphery of the rotating wheel which is in lined with the conveyor belt and is dispatched to the plant as per the need. The Barrel Reclaimer is of cylinder shape and is used for smaller heap of materials. The various sections in a steel manufacturing industries are pallet plant, Sinter plant, Blast furnace and Beneficiation plant [7].The various types of fuels used in different plants are Blast furnace gas, Coke oven gas, Corex gas and LAD gas.

Various hazards take place inside the plants during material handling. Some of them are listed below.

2.1 Population and Sampling

The cases of lower-back injuries and back supports is usually part of any discussion on material handling safety. Much has been written on this subject in recent years, including the pros and cons of back belts [8]. Various studies sometimes contradict each other. Lower Back injuries are mainly common among various workers, although some industries and occupations have more back injuries than others. Back injuries account for nearly 20 percent of all workplace injuries and are the leading cause of injuries to workers under the age of forty-five. The costs associated with back injuries are estimated at $20 to $50 billion per year [9].
Surgeries for some 350,000 spinal injuries are performed each year on all kinds of people.

The most common operation, called a discectomy, entails removing one or more of the jelly-doughnut-like cushions that separate the vertebrae and serve as shock absorbers. Many of these surgeries cost about $30,000 and include at least eight days' hospitalization [10].Approximately 80 percent of the U.S. population will be laid low sometime by an episode of back pain. Incorrect posture is mentioned as a big factor in back problems. Nutrition and exercise are key factors in good back care [11]. Strong back and stomach muscles are the guy wires that support a spine. Being in good physical condition also speeds up a recovery process should one need a back operation [12].The Bureau of Labor Statistics reported that in 1996, of the 6.6 million nonfatal injuries and illnesses,

900,000 cases of back injury were reported. Low-back pain accounts for 18 percent of all workers' compensation claims at Liberty Mutual Insurance Company and nearly one-third of the costs. It is estimated that *25* percent of all workers' compensation cases in California involve the treatment of lower-back problems. A survey of workers' compensation programs was completed by the National Association of Wholesale Grocers Association (NAWGA) and the International Foodservice Distributors Association (IFDA) for 1990. The survey revealed that back sprains and strains among food warehouse workers accounted for 30 percent of all injuries. The report also indicated that in one case more than 54 percent of the back injuries were attributable to manual lifting [13].
In Canada, the warehousing industry has one of the highest rates of back injury. Researchers have connected this to the heavy lifting, awkward postures, and fast-paced work being driven by production[14].Injuries in warehouses are typically not caused by one traumatic event, or one "bad" lift. More commonly, the back injuries are a result of repeated micro tears to the muscles and ligaments in the back, shoulders, and neck. Injuries to the back can be caused by faulty lifting methods, perhaps brought about by the unsuitable storage of product. Most warehouses store products on pallets that are about 4 inches off the floor. As product is removed from a pallet, the worker is forced to bend over more to reach the load [15] . Product is stored within racking stations in this manner to conserve space. Any picking station which is under 6 feet in height can result in poor lifting techniques, which increase the chance for injury.

Table 2.1. Data showing back injuries and back support belts for the different age groups and gender [16]

	Working hours(*1000)		No Injured		Rate per million hours			
Gender	No of back support	Back support	No of back support	Back Support	No of Back support(a)	Back support(b)	Rate ratio 95% cl	Prevented Fraction(%) a-b/a *100%
Women	4056	28380	78	414	19.2	14.6	1.32(1.03-1.68)	24
Men	8756	58698	314	1346	35.9	22.9	1.56(1.38-1.77)	36.2
Age Group								
<25	4197	25594	184	555	43.8	21.7	2.02(1.72-2.40)	50.5
25-34	4888	33896	127	683	26.0	20.2	1.29(1.06-1.55)	22.3
35-44	2121	15588	43	330	20.3	21.2	0.96(0.69-1.31)	
45-54	993	7662	15	125	15.1	16.5	0.91(0.53-1.55)	
55+	612	4465	23	67	37.5	15.0	2.50(1.64-4.16)	60.0

2.2 Back Belts

There are many Contradictory statements over the merits of back belts. Some rate back belts as very effective while others rate them as having no benefit whatsoever. However, by wearing the back belt overall objective of injury prevention which includes the correct application of ergonomics, back injuries can be reduced [17] . Some of the comments regarding the improper use of back support belts include the belt being not properly worn by the user. Mostly manufacturers design the back belts to be worn below the

navel. When improperly worn, the belt is usually placed too high, around the waist. In some cases the belt is not as per appropriate size. Manufacturers make the belts in various sizes and often the user does not get a proper fitting. The belt is worn tightly by the workers at all times rather than tightening them when lifting is required and loosening after the lift. By constantly wearing a back belt in a tight position, back exercise is limited. Workers have a wrong belief that if they wore the belt, they could lift more. This erroneous belief often results in back injuries [18].

2.3 Conveyor Safety

Conveyors are involved in more than 9,000 injuries each year. Causes of the injuries are the disabling, removal, or modification of equipment safety devices; failure to follow proper lockout/tag out procedures; lack of training, and failure to enforce safety rules [19]. Powered conveyors were also the primary source of injury in twenty-three workplace fatalities, 12.2 percent of all plant equipment-related deaths in 1995.

Powered and gravity conveyors were a secondary source of injury in fourteen additional workplace fatalities that year [20]. Some individuals in the material handling industry argue that the improvements in conveyor safety have not kept pace with improvements in other machines and processes. Some of the noticeable improvements, however, include: full enclosures of pinch points such as chain and sprocket transmissions, perimeter pull cords for emergency stops, audible alarms and a delayed start-up function, pop-out rollers, improved warning labels, and interlock guards that are designed to shut off the power if removed.

Many conveyor injuries are the result of missing or defective guarding. Typical conveyor hazards that may require guarding include: drives, gears, couplings, shafts and various power transmission devices. Nip points (or pinch points) where a moving object in a line or a rotating object meets a similarly moving object, such as belts and pulleys, and the meshing of gears.

Side rails and netting on overhead conveyors. Exposed edges of conveyors, because of sprocket and roller mechanism. A transfer mechanism, a device that transfers materials onto or off a conveyor, or from one conveyor to another Counterweights that might fall on the worker while sleeping should be enclosed. Maintenance personnel, workers and contractors who might be exposed to sudden energization Lockout/tag out procedures may be lacking. Despite of improvements in conveyor safety, guards and other safeguards are sometimes removed, thus disabling these safety devices. In one case, a maintenance worker bypassed a safety limit switch by using a jumper wire to disengage the switch. A serious injury occurred because the maintenance worker failed to remove the temporary wire.

Following basic rules will help to prevent conveyor-related injuries. Poor initial layout of the systems lead to many conveyors injury, so it is necessary to take into consideration the various auxiliary hazards when installing the unit. These include guarding, electrical, exits, side-hinged gates, alarms, lights, and hidden pinch point hazards

Always repair or service the conveyor system after proper lockout and tag out procedures has been achieved. Bring the system to the zero mechanical state. Never walk, ride, sit, or climb on a conveyor not intended for that purpose.

Before operating any conveyor one should check for all safety guards, interlocks, guards, covers, maintenance panels, warning devices are in place [21].

One should maintain a safe distance from moving parts of the conveyor while operating.No loose shirts, jewelry, belts, ties or other apparel are appreciated while working on moving parts.The working surfaces must be free of oil or grease so that it does not cause slip and trip hazard.

2.4 Storage system

Basic hazards associated with storage and handling of stock

Injuries that are caused by:-

2.4.1 Ergonomic Hazards (i.e. due to musculoskeletal injury)

- It can be caused by manual movement of goods and product.
- Because of manually lifting of heavy materials without accessing the load.
- Due to manual loading and unloading of product in and out of the trucks.

2.4.2. Slip and fall hazards

-Due to poor housekeeping and poorly maintained floor conditions.

-Because of the work equipment's and wires that had been left unattended.

-Oil and water spillage on the floor, making the floor slippery

2.4.3. Fall from height

- Generally when working on the vehicles without notifying.
- When accessing stocks and storage systems.

2.4.4. Being stucked or rolled by moving stock

- If it falls from a vehicle when loading and loading.
- If the vehicle moves unexpectedly during unloading activities.
- Because of improper lifting and handling techniques it may move or fall.
- Due to failure in the containment and storage systems.

2.5. Control features for hazard mitigation

At first, Manual Material Handling Operations Regulations not only allows the employers but also the workers to abstain themselves from hazardous operations wherever possible, for instance, by mechanization or setting up a safer work culture. Where such operations cannot be omitted, employers should work hand in hand along with the employees in order to:

- Assess and eliminate the risk.
- To be sure that each and every employee know the risk and also how to deal with it.
- Methods to reduce the consequence of risk level or injury as practicable.
- Periodic assessment and review of the techniques and procedures as when required.

The inspection and assessment should contain all the various steps and stages of manual handling operations, wherever there is a chance or risk of injury. This will cover all the situations in which stock is handled. The risk will be forfeited by:

- Particularly heavy stocks or materials are difficult to handle
- If lifting a heavier load then holding load away from the body
- If the distance to be carried is large.
- Objects that requires greater force for pulling and pushing.
- Twisting or reaching far along with the load
- If the load is suddenly picked and moved.
- Balancing of unstable load as the center of gravity tends to change.
- Loads that are not uniform and difficult to catch hold of.
- Sharp and pointed edges that are difficult to handle.
- Working in unfavorable environments (eg. where there is limited space, floors up and down along with slippery surfaces, variations in floor levels, poor lightning or excessive glare).

2.5.1 Reduction in stress level

Handling, storage and proper planning of stock delivery will help to ensure that employees have:

- Sufficient means of equipment for storage, handling, lifting of stocks.
- Provide a system that is safer for performing a work.
- Work environment that is safer in nature.
- Suitable means of training, supervision and instruction.

2.5.2. Barring off must be avoided

A reasonably and practicable, safer alternative means of stock unloading must be available. Risk assessment for various barring activities such as loading and unloading must be reviewed and the risk that are out of tolerable range must be unaccepted.

2.5.3 In order to avoid risk, training to the employees must be given.

No person should be allowed to carry out any material handling and transporting activities until he is certified by proper training agencies. Training is one of the most important thing that must be given, as it helps the workers to recognize the hazards and also to minimize the risk level [22]. The training should cover the following points listed below:

- Recognition of hazardous material handling processes and operations and avoiding them
- The way to deal with unknown operations of material handling.
- Safe use of handling and lifting equipment.
- Detailed information about the musculoskeletal injuries i.e. (How they affect and what they are)
- Early reporting of symptoms that are related to musculoskeletal injuries.

2.5.4 Adopting the steps of Hierarchy of controls

- **Elimination:** These means completely removing the hazardous equipment or procedure.
- **Substitution:** Replacing the hazardous one with a less hazardous one.
- **Isolation:** Isolate the hazard by guarding or enclosing.
- **Engineering Controls:** providing controls such as automation, lev etc.
- **PPE**: Issuing properly and appropriate ppe where other control measures are not applicable.
- **Administrative Controls:-**Imparting necessary training, supervision to the employees regarding safe work practices and also to issue proper SOP regarding any activity.

3. Importance of Inspection and maintenance

Storage facility, racking and handling of material system and equipment must be maintained in efficient state and good condition. As because any equipment or tool may get worn or tear under careful use, so it is necessary to develop a comprehensive

programme of periodic inspection, target maintenance for the equipment (Stephens and Meyers 2013). The inspection and maintenance work must be done by a qualified, trained and competent person. Before using it for the first time inspection must be carried out. Inspection to be made on routine basis. Equipment that are found to be defective must be serviced, repaired or replaced immediately

3.1 Things that need to be inspected.

3.1.1 Work equipment

Inspections of the work equipment should be done prior before taking it into use .Before conducting nay inspection programme and taking into account the recommendations from manufacturer/supplier and appointed competent person should include Inspection of all lifting equipment and accessories, notices and tags regarding floors, guard rails, barriers and SWL must be displayed and storage equipment for lifting attachments.

3.1.2 Work Systems

All the information, instructions, trainings and supervision that are provided to the employees must be checked periodically whether they are safe, adequate and effective (Komaki, Heinzmann et al. 1980).The following systems should be checked.

- Delivery plans and their usage.
- Work system for unloading of vehicles.
- System of stacking for load and stacks.
- Storage system and their usage. Example- material and their compatibility with each other.
- Safe working load not being exceeded.
- Safe systems for storing lifting accessories.
- Use of storage and handling systems across the range of requirements

Table 3.The following table showing equipment along with their frequency of inspection has been mentioned below:-

Items	Frequency of Inspection
All equipment's that are used for lifting purposes. Example- cranes	It must be inspected regularly (daily) before use by operator and also to check the others in accordance to standards. Thorough examination must be done at least annually w.r.t schedule prepared by competent person
Accessories that are used for lifting purposes. Example- chains,ropes,slings	It must be inspected regularly(daily) before use by operator and also to check the others in accordance to standards Thorough examination must be done at least six months w.r.t schedule prepared by competent person
All types of racking and storing systems. Example- notices,SWL	It must be inspected regularly(daily) before use by operator and also weekly/monthly inspection Thorough examination must be done at least annually w.r.t schedule prepared by competent person
Equipment's that are used for accesss.Example- mobile safety steps	Inspection must be made daily and attachment must be for monthly visual inspection
Floors; guide rails; barriers	Inspection must be made daily and regular visual inspection must be made.
Correct use of storage systems	Inspection must be made daily and attachment must be for monthly visual inspection.
Storage arrangements for lifting arrangements	Inspection must be made daily and attachments must be for monthly visual inspection attachments.

4. Conclusion

Workers are vulnerable to injury in warehouses when they are manually or mechanically handling product and equipment. Back injuries occur to over 900,000 workers each year (Edlich, Hudson et al. 2005). Many of the injuries are disabling, which costs industry billions of dollars each year. Using cranes, hoists, conveyors, or forklifts to move product does help to prevent wear and tear on workers, but these devices pose hazards that can maim or kill if proper safeguards are not followed [23]

The correct use of back belts is still hit-and-miss throughout industry. If workers are not instructed properly and the correct use of these devices isn't rigidly enforced, back belts can actually do more harm than good. The Home Depot study appears to be the

most in-depth analysis of back belts to date. The program was successful because of training, proper supervision, and management commitment. More study is needed on the subject of back belts if industry is to move ahead in reducing back injuries.

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