

Occupational Health & Safety in Cement industries

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Abstract:

India is developing country and cement Industries Playing vital role in development of economy of country. In India, there are different cement company such as Ultra tech Cement, Abuja Cement, Shree cement. Cement Industries has Positive and negative impacts. Positive impacts mean such industries create employment opportunities and good for economy development of country. Negative impacts means harm to environment and it causes of environment degradation, negative impacts also cause of injury and create occupational disease among people. This study is carried out to know impacts of cement industries and pollutants generated during different phases of cement production and identifying effective control measure to minimises or control to negative impacts. So this paper is very helpful to control environmental and occupational health risk of cement industries.

Key words: Occupational Health Safety, Impact of cement industries, Occupational Diseases, Environmental & Social Impacts, Safety control measure.

Objective:

- Identifying Occupational health hazard & minimising risk as low as reasonable practicable
- Controlling environmental hazard
- Reducing work injury & cost arises due to accident
- To protect plant personnel and private citizens.
- To prevent or minimize damage of property and protect to environment.
- Prevention of Accidental emissions from stacks.
- Provide measurable systems for verifying OHS performance & finding opportunities for improvement.
- Maintain better relation with stakeholder & enhancing organisation reputation

1. Introduction

Cement industries playing vital role to development of country and create employment opportunities and this is known as positive impacts. Safe workplace in cement industries

plays vital role to prevent occupational health diseases and increasing business opportunities. Different pollutants such as Particulate matter, Sulphur oxide, nitrogen oxygen generates and cause of environmental degradation and ill health and it is known as negative impacts.

The manufacturing units of a cement factory such as raw mill, Preheater, kiln, coal mill, cement mill, storage silo & packing section are point sources of pollution emission. The cement sector is the third largest industrial source of pollution, emitting of sulphur dioxide, nitrogen oxide, and carbon monoxide and it effect to environment and health of people. Exposure of cement dust can develop lungs cancer, pneumoconiosis, respiratory system damage, skin irritation, dermatitis, skin burn, conjunctivitis, headache, fatigue, eye injury as well as stomach and colon problem. According to studies reported with respect to oral cavity, the mostly reported diseases in workers are inflammation of gums (gingivitis), dental caries, calculus and pockets formation, loss of surface area of teeth and also periodontal diseases. This depend on duration of exposure of dust. Eye also effected when cement dust particles enters in eye. Pollutants generated from cement manufacturing industries also effect to structure, Tree & animals. Apart from this Noise generated from cement industries and exposure beyond permissible limit also effect to our hearing system.

Joint ILO/WHO Committee on Occupational Health (1950)

Occupational health is the

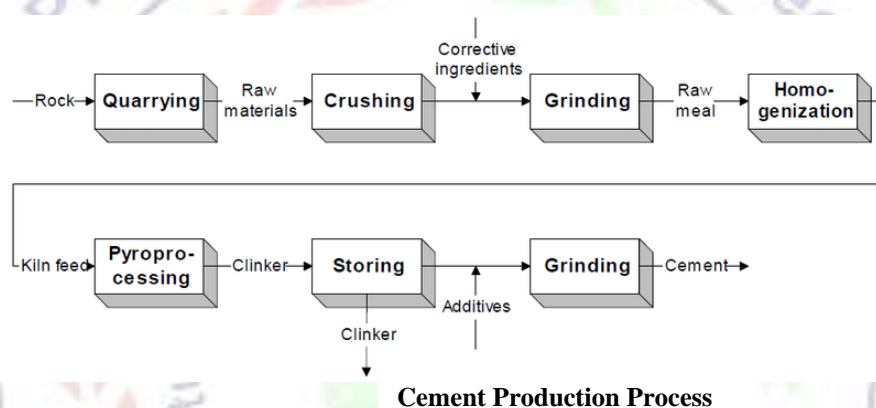
- promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations;
- the prevention amongst workers of departures from health caused by their working conditions;
- the protection of workers in their employment from risks resulting from factors adverse to health;
- the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities

and; to summarize: the adaptation of work to man and of each man to his job



2. Cement production Process, Characterisation, Composition & Types

The cement production process consists of drying, grinding and mixing limestone and additives like iron and bauxite ore into a powder known as "raw meal". The main raw material used in cement industry are limestone (CaCO_3), sandstone (SiO_2), clay, bauxite (N_2O_3) and gypsum ($\text{Ca}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$) and involves the release of various particulates, dust, gases and heavy metals. The raw meal is then heated and burned in a pre-heater and kiln and then cooled in an air cooling system to form a semi-finished product, known as a clinker. Clinker (95%) is cooled by air and subsequently ground with gypsum (5%) to form Ordinary Portland Cement (OPC).



Cement may be defined as, calcined mixtures of clay and limestone, usually mixed with water, sand, gravel, etc., to form concrete, that are used as a building material for civil work. It may also be defined as a powdery substance used for binds or unites.

Portland cement consists essentially of compounds of calcium oxide (CaO) (61% - 67%), silicon oxide (SiO_2) (19% - 23%), Aluminum tri oxide (Al_2O_3), (3-6%), ferric oxide (Fe_2O_3) (2% - 6%), magnesium oxide (MgO) (1% - 2%) 5 and also selenium, thallium and other impurities.

Basically cement are two types, natural and artificial cement. The artificial cement is also called Portland cement. Portland cement is further classified into Portland blast furnace cement (PBFSC), Sulphate Resisting Portland Cement, Ordinary Portland Cement (OPC), Portland Pozolona Cement (PPC), Rapid Hardening Portland Cement, Oil Well Cement, Clinker Cement, White cement. Apart from these, some of the other types of cement that are available in India can be classified as: Low heat cement, High early strength cement, Hydrophobic cement, High aluminium cement, Masonry cement.

3. Impacts of Cement Industries

Producing cement has significant positive and negative impacts. On the Positive side, the cement industry create employment and business opportunities for people. This play vital

role for economic development of country. Negative impacts include disturbance to the landscape, and disruption to local biodiversity from quarrying limestone (the raw material for cement) like activity and effect to living thing.

Safety issues vs. Occupational Health issues in cement industries

Safety	Occupational Health
We can usually see something coming & hitting the person. (except acute exposure to gases)	We can't see.
Result is immediate.	Result is delayed, may be after years!
Safety risk assessment (QRA), checklists etc. are required.	Personal exposure monitoring is required.
Awareness among employees and contract worker is comparatively better!	Comparatively less!
Common is –"Pain/suffering to us"	

Known Facts

- Occupational Diseases are **notifiable & compensable** diseases in almost all geographies.
- For most of occupational diseases – **no cure**. Almost all are **preventable**.
- Occupational diseases have a **long latent period** – not felt as priority.
 - Silicosis takes 6 to 9 years to develop
 - NIHL takes 8 to 12 years to develop
- Liver cancer takes 20 to 30 years to develop

In this study we will discuss about Negative impacts.

3.1 Negative Impacts:

The cement sector is the third largest industrial source of pollution, emitting more than 500,000 tons per year of sulphur dioxide, nitrogen oxide, and carbon monoxide.

Chronic exposures in cement industries, workers suffer from impairment of respiratory system function, lungs cancer, Headache, fatigue, stomach and colon. It also effect oral cavity & eye, the commonly reported symptoms concerned with oral cavity of cement industries workers are inflammation of gums, calculus and pockets formation, dental caries

and non carious tooth surface loss. Basically three types of air pollutants are released to the air during cement manufacturing which includes particulate matter (PM), nitrogen oxides (NO_x) and sulphur dioxide (SO₂).

Portland cement is caustic, so it can cause chemical burns, the powder can cause irritation or with severe exposure this may causes of lung cancer and can contain some hazardous components such as crystalline silica and hexavalent chromium. Environmental concerns are the high energy consumption required to mine, manufacture, and transport the cement and the related air pollution including the release of greenhouse gases (e.g., carbon dioxide), dioxin, NO_x, SO₂, and particulates.

In cement industries, most health problems are chronic cough, phlegm production, impairment of lung function, chest tightness, skin irritation, conjunctivitis, stomach ache, headache, fatigue, carcinoma of larynx, colon also effected due exposure of such hazardous agent. Cause of such diseases are unavailability or poor condition of dust collection system, Poor housekeeping, Non availability of personal protective equipment's (PPE's), use of defective personal protective equipment's (PPE's) or not using personal protective equipment's (PPE's) due to unawareness, so workers do not adequately protect themselves through personal protective device. Such conditions are also consistently associated with concentration and time of exposure, Personnel hygiene & behaviour, Personnel tolerance level, susceptibility, State of matter, & regular use of appropriate personal protective equipment. Route of exposure are inhalation (breathing in), absorption through skin or eye & ingestion. Exposure of Noise beyond permissible limit also create headache, nausea, increase in blood pressure and long term exposure may cause of noise induced hearing Loss. Pollutants emits during operation effect to environment.

Generated Pollutant Data as per Cement Sustainability Initiative (CSI)

Key Performance Indicators as Per CSI (Europe), Data (reported 2011 unless otherwise specified)

Sl. No.	KPI	Range	Companies Reported
i	Specific NO _x emissions (g/ton clinker)	844 - 1,915	14 reporting members
ii	Specific SO _x emissions (g/ton clinker)	77 - 1,247	14 reporting members
ii	Specific Dust emissions (g/ton clinker)	58 - 613	14 reporting members

As per CSI, Table 1

3.1.1 Environment Impact

Generated pollutants during different process stage in cement industries always effect to environment. It mix in air, water and land and polluted them. Such pollutants enter in our body through inhalation, skin absorption & ingestion and effect to our health. Major pollutants are NO_x, SO₂ & CO. These include emissions of airborne pollution in the form of dust, gases and fumes during quarrying, material handling and crushing like activity. Noise and vibration also generate during machinery and equipment operation and other operational process during cement manufacturing, that effect to environment and human being.

Inhalation of SO₂ causes Irritation of throat, nose etc and causes death when in high concentration. It also creates respiratory and cardiovascular disease. SO₂ is also a primary contributor to acid deposition, or acid rain. Same as inhalation of CO₂ causes asphyxiation or breathlessness. High concentration of CO₂ may cause of death also. Carbon monoxide (CO) also reduces oxygen delivery to the body's organs and tissues, as well as adverse effects on the cardiovascular and central nervous systems. CO also contributes to the formation of smog (ground-level ozone), which can cause respiratory problems. Nitrogen oxide (NO_x) can cause or contribute to a variety of health problems and adverse environmental impacts, such as ground-level ozone, acid rain, global warming, water quality deterioration, and visual impairment. Affected populations include children, people with lung diseases such as asthma, and exposure to these conditions can cause damage to lung tissue for people who work or exercise outside. Cement manufacture contributes greenhouse gases both, directly through the production of carbon dioxide when calcium carbonate is heated, producing lime and carbon dioxide and indirectly through the use of energy, particularly if the energy is sourced from fossil fuels. The cement industry produces about 5% of global man-made CO₂ emissions, of which 50% is from the chemical process, and 40% from burning fuel. The amount of CO₂ emitted by the cement industry is nearly 900kg of CO₂ for every 1000kg of cement produced.

4. Hazard Control method in Cement Industries:

In cement Industries, Occupational Health hazard can be controlled through environmental control and Hazard control method including Health monitoring.

4.1 Environmental Control

Environmental control Comprises improvement in general ventilation system there by diluting the Dangerous dust, gases and fumes to such concentration level so as to maintain the permissible limits

prescribed for the relevant contaminants. Total Enclosures of hazardous process with exhaust system by using the principle of segregation may be used as effective control method. This is called engineering control method. Enclose to conveyor like system is best method to control dust emission that emit during raw material handling and spread in working atmosphere. This help to Protect environment and preventing occupational diseases.

All filters, Lines and connectors, shall be designed to prevent leakage of particulate or contamination. Regular monitoring must be done to identifying such leakage and taking corrective action on same time to prevent dust emission in atmosphere.

Noise is also source of pollution that effect to people to create headache, Nausea, develop hypertension and long term exposure may cause of noise induced hearing loss. Noise may be reduced to use enclosure, Barriers and functional sound absorber.

Electrostatic Precipitator (ESP), Bughouse Filters, Monitoring equipment like device also used in cement industries for dust control. ESP control devices ionize contaminated air flowing between the electrodes. The charged particles (contaminants) travel to the oppositely charged plates. The particles on the plates are removed. These particles can be dry dust or liquid droplets (liquid droplets are more efficient). The particles that are removed from the plates are knocked off to the bottom of the ESP. ESPs have high efficiency and low pressure drops.

These devices are used after the roller mill and after the cement kiln in the production of cement to reduce emissions of particulate matter such as cement kiln dust. Often spray towers are used before the ESP (Fig. 2) in order to moisten the particulates, increasing ESP efficiency. In Baghouse Filters, polluted air is filtered through the bags. The bags are closed at the bottom, and are exposed to a clean air chamber at the top. The bags are cleaned by short bursts of pressured air. The bags contracts and snaps which releases the particulate layer. Bughouses are used in cement production at the top of material storage silos and gas separators. They help prevent any particulate matter escape the process. Anything collected in the bag filters (Fig. 3) is simply release back into the process to be used in the cement making. Generation of Electrical Power to use waste flue gases that contains CO₂ is also good method to protect environment and prevent occupational health diseases. Power is generated through waste Heat recovery boiler (WHRB) to use waste flue gases. Apart from this water sprinkling system, enclose to conveyor belt to prevent dust emission, Sweeping m/c like equipment also used for controlling dust.

4.2 Occupational Health Hazard Control

Recognize the hazard and eliminate it or Control at source through dust collecting system or other engineering control method. Water sprinkling & ensuring good housekeeping on regular basis is also best method to controlling dust and preventing occupational health diseases.

Maintain dust control systems on regular basis for keeping them in good working order. Conduct air monitoring to measure worker exposures and ensure that controls are providing adequate protection for workers.

Cement industry workers should wear suitable personnel protective equipment like high-efficiency particulate arresting or high-efficiency particulate air (HEPA) mask, safety goggles and mandatory get pre-employment and medical surveillance on periodically. Use safety gloves also for preventing dermatitis like disease. Displayed post warning signs inside factory & Provide training to workers and staff's for creating awareness and taking suitable safety control measure. Report all occupational Health disease to OHS centre & Govt. authority. This will help to reducing the risk of Occupational hazards of cement dust in the cement industry workers.

- All disease that created inside plant due to cement dust, fumes and gases, Noise must be investigated and preventing measure must be taken to avoid similar future diseases.
- Use Enclosure, absorber and barrier like devices for reducing noise level and use Ear plug and goggle like PPE's is a techniques to protect ear and eye from such diseases.
- Risk must be identified in every process and operational activity and take adequate control measure for minimising its level as low as reasonable practicable (ALARP) to prevent occupational health diseases and Protect to environment.

Hazard is controlled through hazard control method that is known as hierarchy of hazard control measure. To use of PPE's last consideration of hierarchy of hazard control method because not eliminate to hazard, it minimise severity of harm.

The Limestone mining also need focus on the following to improve the Occupational Health & safety compliances.

- Initial and periodic medical examination
- Training of medical officers in Occupational health and hygiene.
- Training of medical officers for use of standard ILO chest radiographs for classification of pneumoconiosis
- Hierarchy of controls for prevention of Occupational diseases
- Rehabilitation of affected persons
- Equipment and other arrangements to safe guard from occupational illness.

4.3 Health & Biological monitoring

Health Monitoring:

Check & Monitor	At the time of Employment...	During Employment	At the time of separation
Fitness to work (for specific jobs)	Yes	Yes	--
Medical checks for exposure (for specific SEGs)	Yes (for baseline records)	Yes	Yes
Wellness checks	--	Yes	--

Fitness to Work – Why?

- Safety of person
- Worsening of Personal Health & life expectancy
- Productivity
- Baseline Record
- Occupational Diseases & other diseases' burden
- Statutory Compliance
- Well informed decision making process

Periodic Checks– Why?

- Early detection of adverse Health effects and abnormalities
- Job rotation in case required
- Helps for Intervention / health promotion strategy
- Checks effectiveness of preventive & control measures
- Preventing spread of communicable diseases
- Statutory compliance

Biological monitoring (BM). Why?

- BM can assess total uptake in body by all routes
 - Inhalation
 - Ingestion
 - Skin Absorption
- BM can assess efficacy of...
 - PPE

– Engineering controls

Procedural Control / Human factors

Biological Monitoring:

Assessment of overall exposure to chemicals by measurement of the chemicals or their breakdown products in



Fig. 1a

- Biological markers represent events or changes in human biological systems as a result of exposure or disease.
 - ✓ Markers of exposure,
 - ✓ Markers of effect
 - ✓ Markers of susceptibility
- Represent an individual's **total dose**
- Evaluation of an individual's **total exposure**
- Believed to be **more predictive of health effects**

Examples of chemicals that can be assessed by biological monitoring

Biological Monitoring (Measuring the Chemical itself)		
In blood	Lead, Cadmium, Polychlorinated Biphenyls	
In urine	Cobalt, Nickel, 4,4'methylenebis-(2-Chloroaniline)	
In Breadth	Tetrachlorethene, Carbon Monoxide	
Biological Monitoring (Measuring a metabolite)		
In Blood	Bromide	From Methyl bromide exposure
In Urine	Mandelic acid	From Styrene
	Trochloroacetic acid	From Trichloroethene

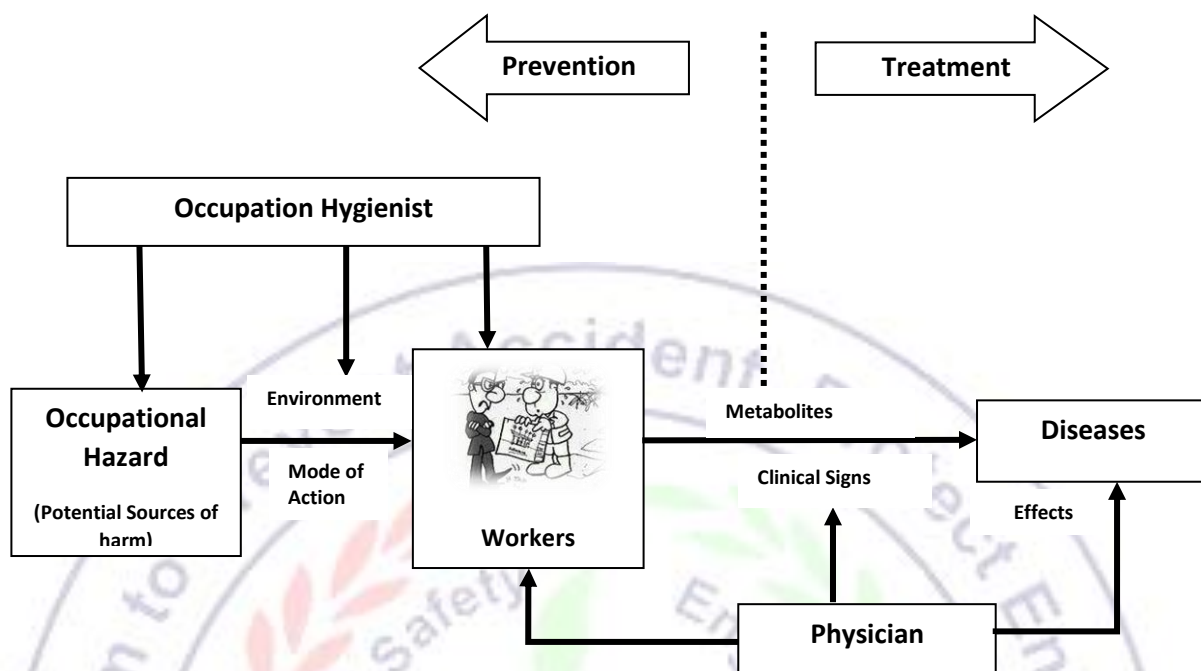


Fig. 1b, Occupational Health Safety in cement industries

Conclusion: The main sources of health disease in cement industries are Polluted air. SO_x, NO_x, CO type different Pollutant emits and mix with air and spread in work environment may cause of occupational & Health diseases due to inhalation, ingestion & direct contact. Dangerous agent such as dust, fumes, gases also effect to eye and other living thing. Noise generated from machinery, equipment and other operation of cement manufacturing may causes to hearing loss due to exposure beyond permissible limit. Apart from dust, fumes and gases and other hazard associated in cement industries like Mechanical (Entanglement, Contact, Sharp edge etc), Electrical (Electrocution, Shock, fire), Fall hazard, Vehicle movement, Physical (Heat, poor illumination), Chemical hazard, Fire hazard (Naked flame, Hot material) etc. Risk can be minimise to control workplace hazard to take adequate control measure and effective implementation of Occupational Health Safety Management system. Safe work place minimise Numbers of injury and increases productivity of organisation. Potential source of harm in cement industries can be controlled through hazard control method.

Permissible levels of certain hazardous substance in work environment

Substances	Time weighted Average concentration (TWA) in ppm (8 hours)	Short Term exposure Limit (STEL) in ppm(15 minutes)
Carbon monoxide	50	400
Sulphur dioxide	2	5
Nitrogen dioxide	3	5
Ozone	0.1	0.3

Sources, Schedule II of The Factories Act 1948 (India), Table 2

Permissible Noise value, Noise Regulation (Regulation & Control) Rule-2000 (India).

Category of Area/ Zone	Day Time Limits in dB (A) Leq*	Night Time Limits in dB (A) Leq*
Industrial Area	75	70
Commercial area	65	55
Residential area	55	45
Silence Zone	50	40

Table 3, Sources, NRR-2000 (India)

Note: Day time means 6:00 AM to 10:00 PM and Night Time means 10:00 PM to 6:00 AM, Table 3



Fig. 2 (Source)



Fig. 3 (Source)

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