MINES SAFETY ASSOCIATION KARNATAKA

Directorate General of Mines Safety

Ministry of Labour & Employment
Government of India

Seminar on

"SILICOSIS AWARENESS"

14th August, 2019 at 11.00 AM
at Hotel Malligi, Hosapete

MINES SAFETY ASSOCIATION KARNATAKA

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Shri K.B Verma
Secretary, MSAK Zone-IV
& General Manager (Mines), M/s. ACC Limited, Wadi.

LIST OF TECHNICAL PAPERS

1. Office Bearers

Technical Papers

1). Respirable Dust, Silicosis of Miners and It's Prevention	:	Shri Mihir Choudhury Director of Mines Safety Ballari Region
2). Silicosis	:	Dr. Swarupa Padhi Sr. Medical Officer M/s. NMDC Limited
3). Dust in Mining Industry	:	Dr. Raviprakash. K.C Sr. Medical Officer M/s. JSW Steel Limited (OHC)
4). Silicosis – Prevention is better than Cure	:	Shri D.P. Mukhopadhyay Sr. GM (Mines) M/s. UltraTech Cement Ltd
5) Silicosis Awareness	:	Shri Ramamohan Reddy VT Manager, C.N.Halli
6) Effects of Silicosis in Stone Quarrying and Mining	:	Shri Ganesh Murthy Sr. Mines Manager M/s. Bannari Amman Sugars Limited
7) Silicosis – Take Control of it before It takes control of you	:	Dr. Krishnamurthy KV Residential Doctor M/s. Vedanta Limited

RESPIRABLE DUST, SILICOSIS OF MINERS AND IT'S PREVENTION

Mihir Choudhury
Director of Mines Safety

1. Background

Everyday many of mines' workers come across various physical, chemical, biological and ergonomic hazards. Repeated exposure to such hazards lead to development of occupational diseases. All occupational diseases, as a rule, are preventable and most do not have any treatment. Management of these diseases is largely based on supportive therapy and symptomatic treatment. Due to lack of awareness among doctors, employers and employees, want of expertise and inadequacy of infrastructure facilities required to establish diagnosis, most occupational diseases still go undiagnosed and undetected.

2. History

Dust is an old health hazard in mines, even in sixteenth CenturyGeorgiusAgricola , a physician working in an iron ore mining and smelting community in Bohemia mentioned that mine dust ulcerated the lungs and caused consumption specially in the mines which were very dry. Dr. Zenker in 1866 introduced the term Pneumonokoniosis to mean the dusty lungs, coining it from the two greek words, 'Pneumono' meaning lungs and 'konios' meaning dust, subsequently Adrian Proust of France abbreviated it to Pneumoconiosis in 1874.

Now pneumoconiosis is used as a generic term covering lungs diseases resulting from inhalation of all kinds of dust that causes a permanent lesion of the cardio-respiratory organs. More specific names have been given to lungs diseases caused by particular kind of dust. Until the first quarter of the twentieth century, it was thought that only hard rock mining caused pneumoconiosis, more specifically silica dust causing silicosis but many cases of coal workers pneumoconiosis was reported from British and American coal mines subsequently.

South Africa was the first country in the world to make silicosis a compensable disease and in 1912 enacted legislation governing working conditions in gold mines. The UK and the USA followed suit in making silicosis compensable under the workmen's compensation Act in 1925 and 1936 respectively. In India, silicosis arising from inhalation of gold mine dust was made compensable in 1940 under the Mysore state Govt. Rules on the subject.

Silicosis is caused by the breathing of dust containing free crystalline silica over a long period of time.

3. Status of Occupational Diseases in Indian Mines

Under the Constitution of India, Safety, Welfare and Health of workers employed in mines are the concern of the Central Government (Entry 55-Union List-Article 246). The objective is regulated by the Mines Act, 1952 and the Rules and Regulations framed thereunder. These are administered by the Directorate-General of Mines Safety (DGMS), under the Union Ministry of Labour & Employment.

A list of the subordinate legislation under the Mines Act, 1952 and certain allied legislation administered by DGMS are –

- Coal Mines Regulations, 1957
- Metalliferous Mines Regulations, 1961
- Oil Mines Regulations, 1984
- Mines Rules, 1955

The Central Government has notified following diseases to be connected with mining operations for the purpose of sub-section (1) of Section 25 of the Mines Act, 1952 and the mine management is required to submit a notice of occurrence of notified diseases among the mine worker;

- Silicosis
- Pneumoconiosis
- Manganese Poisoning - Nervous type
- Asbestosis
- Cancer of lung or the stomach or the pleura and peritoneum (i.e.mesothelioma)
- Noise induced hearing loss.
- Contact Dermatitis caused by direct contact with chemicals.
- Pathological manifestations due to radium or radioactive substances.

3.1 Cases of Notified Disease reported by Mine Management to Directorate General of Mines Safety

Year	Coal Workers' Pneumoconiosis	Silicosis	Noise Induced Hearing Loss(NIHL)
2000	7	11	-
2001	0	1	-
2002	2	16	-
2003	4	17	-
2004	37	9	-
2005	9	33	-
2006	4	0	-
2007	7	0	-
2008	1	3	-

Year	Coal Workers' Pneumoconiosis	Silicosis	Noise Induced Hearing Loss(NIHL)
2009	0	0	-
2010	1	0	-
2011	5	1	-
2012	5	0	2
2013	0	4	-
2014	0	1	-
2015	0	0	8
2016	2	0	-
2017	2	0	-
2018	2	8	-
2019 as on 30.6.2016	1	0	0

3.2 In addition, Occupational health survey is being conducted by this Directorate. The details are as under:

(i) In pursuance of the interim order of Supreme court on Silicosis in the year 2016, Occupational health survey was carried out in various state from Year 2016 to 2019 (till date) by this Directorate with the help of state Government to detect cases of silicosis. 10589 persons have been examined and so far 255 cases of silicosis have been detected, details given below:

State	Sector	Occupational Disease	Year of Detection			
			2016	2017	2018	2019 till 30.6.19
Jharkhand	Non-coal	Silicosis	-	11	-	-
Rajasthan	Non-coal	Silicosis	-	100	3	-
Madhya Pradesh	Non-coal	Silicosis	-	12	36	-
Karnataka	Non-coal	Silicosis	-	5	4	18
Gujrat	Non-coal	Silicosis	-	7	1	-
Tamilnadu	Non-coal	Silicosis	-	19	-	-
Telengana	Non-coal	Silicosis	-	3	8	-
Chattisgarh	Non-coal	Silicosis	-	-	2	-
Andhra Pradesh	Non-coal	Silicosis	-	-	-	11
Goa	Non-coal	Silicosis	-	-	-	15

(ii) Occupational Health Survey conducted by National Institute of Miners' Health, Nagpur in collaboration with DGMS From Year 2016 to 2018 to detect cases of silicosis. 2537 persons have been examined and 136 cases of silicosis have been detected, details given below :

State	Sector	Occupational Disease	Year of Notification		
			2016	2017	2018
Rajasthan	Non-coal	Silicosis	-	98	16
Utter Pradesh	Non-coal	Silicosis	-	7	-
Madhya Pradesh	Non-coal	Silicosis	-	-	15

iii) Result of Occupational health survey carried out in mines under Ballary Region from Year 2017 to 2019 (till July) by this Directorate :

Sl. No.	Mineral	Type of Mine	No. of Persons examined	No. of persons detected silicosis	percentage
1	Gold	Underground	405	5	1.2 %
2	Limestone (Cement sector)	Opencast	342	13	3.8 %
3	Granite	Opencast	419	9	2.15 %
4	Iron ore	Opencast	504	1	0.2 %
5	Steatite/Dolomite/ Small limestone mine	Underground/ Opencast	210	11	5.2 %

4.0 Magnitude of the problem

In India there are about 1.7 million workers engaged in industries with the potential risk of exposure to silicosis dust and subsequent development of silicosis.

5.0 Human respiratory system and defense mechanism of lungs

Air enters through the nostrils and goes via the nasal cavity (nasopharynx), throat(larynx) and windpipe(trachea) to reach the bronchial region where the trachea branches into the right and left lung bronchus. These branch repeatedly into smaller bronchioles and the smallest bronchioles measuring approximately 0.6 mm in diameter terminate in clusters of air sacs or alveoli.The walls of the alveoliprovide a wall of only 0.55 mm in thickness known as epithelium across which gas exchange between the blood and air occurs. An average human lung contains an estimated three to four hundred million alveoli with a total area approximating 75 m2. The lung tissues have

elasticity so that during expansion of the rib cage and lowering of the diaphragm muscle the lung expands. Breathing rate of a person may vary from 12 to 40 inhalation per minute depending on the level of activity of the person. With long period of fine fibro genic dust deposition in the lungs, some of the lung tissues suffer reduction of elasticity resulting in reduction of inhaled air volume and an affected person suffers from breathlessness, especially while doing hard manual work. In extreme cases the man may be completely incapacitated, unable to perform simple activities such as walking or climbing stairs and additional strain put on the heart may even lead to heart failure. In halation of non-fibrogenic carbonaceous or metal dusts such as coal, graphite, iron,tin, barium does not lead to development of fibrotic lesion and hence not as dangerous as the inhalation of fibrogenic dusts.However , accumulation of non-fibrogenic dust can also give rise to overloading of the defense mechanism of the lungs and result in formation of plaques within the alveolar walls and small airways and interfere with proper functioning of the lungs.

The human body has a number of defense mechanisms against the deposition of dust and development of dust diseases. The nasal hairs in the nostril act as filter for large dust particles. The nasal cavity is lined with mucous membrane where again coarse size dust (say above 10 micron size) gets deposited as the air velocity reduces in the cavity having a large cross section. The upper respiratory passages i.e. the nasopharynx, trachea, bronchi and the bronchioles are lined with hair like structures or cilia and mucous secreting cells. The cilia are constantly in motion in a wave like manner that assists movement of the mucous towards the throat from where it is either coughed up or swallowed. Particulates in the range of 5 to 10 micron reach the alveoli. For dusts of 20 to 200 micron size, maximum deposition takes place in the nasal passage, for dusts 2 to 20 micron size, maximum deposition takes place in the tracheal and bronchial parts and deposition of dusts of less than0.2 micron size takes place mostly in the alveolar region. Of the particles that reach the alveoliof the lungs, only a part is retained. Dust which does not settle in the lungs, goes out with the exhaled air. Very small particles of , say less than 0.3 micron size are imparted a random motion(known as Brownian motion) by continuous bombardment by air molecules and hence these particles get deposited in the lungs mainly by diffusion. A major part of the deposited dust is removed by the macrophages present in the lungs.

Maximum retention in the alveoli is for dust of size between 1 and 2 microns at around 60%, reduces exponentially to about 6 % as the size goes up to 5 micron and the retention percentage also falls down to about 20% as the dust size goes down to 0.2 to 0.3 micron size.

6.0 Silicosis in Mines

The mining industry in India is spread all over geographical area and is often located in some of the most inaccessible places. There are about 580 coal mines and more than 6000

estimated metalliferous mines. In addition, there are thousands of small mines which either do not come under the purview of Mines Act or do not report.

The problem of silicosis is likely to be more severe in small scale mines because of certain characteristic features of these mines. Most of these mines are run by small entrepreneurs with limited financial resources and inadequate technical know how. The working is seasonal and the turnover of labour is very high. The labour force is unorganized and lacks the ability of collective representation against exploitation like long hours of work, low wages, unchecked workplace hazards etc. Medical facilities are usually non-existent. Due to high labour turnover and absence of medical examinations cases of silicosis usually pass unnoticed.

It is difficult to make any reliable estimate of prevalence of silicosis in the mining industry as the number of cases of silicosis notified to Directorate General of Mines Safety reflect only tip of the proverbial ice-berg. No estimate whatsoever can be made of prevalence of silicosis in small scale mines where some of the dustiest operations predisposing to silicosis are carried out.

6.1 Sources of Generation of Dust :

Dust is produced whenever rock or mineral is broken by impact, abrasion, crushing,cutting, grinding or by blasting. Dust is produced during wining of the mineral and it's transport out of the mine as well as from ancillary operations such as roadway maintenance and roof support operations. The major sources of dust in mines are as follows :

- DRILLING OF BLAST HOLES
- CLEANING & STEMMING OF BLAST HOLES
- BLASTING
- DRESSING OF LOOSE ROCKS
- FACE CLEANING, SWEEPING OF FINES
- MINEARAL & WASTE HANDLING
- MOVEMENT OF ROLLING STOCK ON HAUL ROADS
- ROCK CRUSHING, GRINDING. MILLING
- SCREENING, PULVERISING, ORE DRESSING
- WASTE DUMPING & BACKFILLING

7.0 Statutory provisions relating to health surveillance for silicosis

7.1 Mines Act

Under the Constitution of India, Safety, Health & Welfare of workers employed in mines are the concern of the Central Government (Entry 55-Union List-Article 246). The objective is regulated by the Mines Act, 1952 and the rules and regulations framed there under. These are administered by the Directorate-General of Mines Safety (DGMS), under the Union Ministry of Labour & Employment. Specific provisions have been made to protect workers from Occupational Health hazards and prevent occurrence of Occupational diseases. Some of the important statutory provisions under Mines Act, are;

7.1.1 Notice of Diseases

The mine management is required to submit notice of occurrence of Silicosis;

7.1.2 Medical Examinations

(a) Initial medical examination of every person to be employed in the mine.

(b) Periodic medical examination, once every five years of persons employed in the mines.

❖ The routine initial or periodic medical examination should include –

❖ General physical examination,
❖ A full size postero-anterior chest radiograph
❖ Lung function tests (spirometry)

7.1.3 Monitoring of Airborne Respiratory Dust Levels

Coal Mines Regulations, 2017 and Metalliferous Mines Regulations, 1961 prescribe the permissible limits for various type of airborne respirable dusts, dust sampling strategies and control measures required to be adopted in mines. The important provisions are;

The 8-hrs time weighted average permissible limits for airborne respirable dust as determined by use of approved dust sampling instruments and procedures are –

- 1 fibres per milliliter of air in case of asbestos.
- 5 milligrams per cubic metre of air in case of manganese ore.
- 3 milligrams per cubic metre of air; where the working is being made wholly in coal seam or where free respirable silica content in respirable dust is less than 5%.
- In other cases where free respirable silica content in respirable dust is more than 5 percent, the permissible limit shall be calculated by the formula, 15% of free silica in milligrams per cubic metre of air.

7.1.4 Recommendations of Conference on Safety in Mines

In addition to the statutory provisions relating to Occupational Health prescribed under Mines Act, 1952, and Rules and Regulations framed there under the issues related to Health Surveillance in Mines are discussed in Conferences on Safety in Mines. Some of the important recommendations of Conferences on Safety in Mines are;

(a) Training of medical officer in Occupational Health and use of ILO Classification of Radiographs for Pneumoconiosis.

(b) Certification of pneumoconiosis at profusion 1/1 or more as per ILO Classification.

(c) Medical examination of every person within one year of superannuation.

(d) Computerisation of records of medical and environmental surveillance.

(e) Classification of chest radiographs of Initial and Periodical Medical Examinations for detection, diagnosis and documentation of pneumoconiosis in accordance with ILO classification for pneumoconiosis.

(f) Setting up of an Occupational Diseases Board consisting of one Occupational Health Physician, one Radiologist and one General/Chest Physician.

7.2 Compensation of Silicosis:

Disability allowance and compensation for occupational diseases

under Section 9A of the Mines Act, 1952 and Rule 82A of the Mines Rules, 1955 :

Any person who, on examination under occupational health survey, is found medically unfit to discharge the duty which he was discharging in a mine immediately before such examination:

- Medical treatment at the cost of the owner with full wages during the period of such treatment.
- Alternative employment in the mine for which he is medically fit
- Disability allowance at the rate of fifty percent of the monthly wages that he was in receipt of immediately before presenting himself for the medical examination.
- If, a person decides to leave his employment in the mine, he shall be entitled to compensation as may be admissible under the provisions of the Workmen's Compensation Act ,1923 The lump-sum compensation payable under this rule shall not be in addition to the compensation payable under that's Workmen Compensation Act..

Silicosis is a compensable disease under Section 3 of Workman Compensation Act, 1923.

- The compensation in payable even after cessation of employment.
- The quantum of compensation depends on disability and loss of earning capacity.

8.0 Organisations associated with Detection, Prevention and Control of Silicosis

India being a federal state, health, safety and welfare of persons employed in various jobs are regulated by Union of India as well as State Governments. While health safety and welfare of persons employed in mines are regulated through the Mines Act, 1952, health safety & welfare of persons employed in factories is regulated by State Government through Factory Act, 1948. Model Factory Rules however, are framed by the Directorate General of Factory Advisory Services & Labour Institutes of Govt. of India. There is no formal National Programme on elimination of Silicosis in India; however, the Union of India and State Governments and various other agencies play an important role in detection, management, prevention and control of silicosis.

9.0 Research and Academic Institutions

Research Institutes such as National Institute of Occupational Health, National Institute of Miners' Health, other academic institutes also play an important role in detection of cases of silicosis. These institutions conduct surveys and studies on silicosis either on there own or as and when the problems are referred to them by various agencies including government.

10.0 Present activities in detection of

Silicosis:

Director General of Mines Safety in collaboration with other agencies has organized series of workshops on "Silicosis Awareness" and conducted " Occupational health Survey" of workers engaged in organised as well as in unorganised sector mines.

11.0 Short-comings of Occupational Health Services in Mines.

Inspection of occupational health and hygiene facilities in various mining companies by the officers of DGMS have shown that implementation of statutory provisions and recommendations of Conferences on Safety in Mines pertaining to occupational health and hygiene has not been satisfactory. Majority of companies are yet to set up proper Occupational Health Services as recommended by Conference on Safety in Mines. Far more efforts will be required to implement recommendations of IX th Conference on Safety in Mines.

Some important deficiencies observed during inspection and evaluation are:

1. Lack of infrastructure facilities for conducting medical examinations in PME Centres.
2. Failure to conduct Initial and Periodical Medical Examinatins of Persons employed in mines.
3. Failure to evaluate chest radiographs as per ILO Classification.
4. Non-reporting of cases of notified diseases.
5. Lack of infrastructure facility for conducting dust surveys.
6. Failure to conduct dust surveys.
7. Lack of trained manpower in occupational health and hygiene.
8. Lack of organizational framework on occupational health and hygiene.

Of the various mining companies inspected and evaluated for status of occupational health and hygiene, most did not have the requisite infrastructures for Occupational Health Services as envisaged and recommended by VIIth of Conference on Safety in Mines.

Apart from this the problem of occupational health services Is more severe in small scale mining areas specially those owned by small private mine owners due to lack of awareness, financial incapability inadequate trained occupational health experts/hospitals in the small towns.

12.0 Prevention of Silicosis

"Silicosis prevention techniques involve limiting the release of silica dust into the air". Tried and tested silicosis prevention techniques essentially involve limiting the release of silica dust into the air and implementing proper ventilation to keep the dust away from the lungs of miners. The most effective engineering controls should be a combination of wet methods, ventilation and shrouding or separating the individual from where the dust is generated. Typical measures to limit airborne dust in the first instance include water spray systems to wet down drilled rock and chemical applications on underground walls that cause dust to stick to them.

These measures require particular will to install because, due to the long-dormant nature of silicosis symptoms, it can take years for the benefits to be properly measured.

Although monitoring the health of workers is

an important method of building data on silicosis, active prevention methods are the only sure way to curb the disease. The important thing about medical monitoring is that it identifies the problem after it occurs. Medical monitoring is a secondary prevention effort, but where we know that the process creates the generation of silica dust. We need to be aggressive in controlling the dust and reducing or eliminating exposures. As such medical monitoring provides information, but it doesn't prevent disease, it documents it.

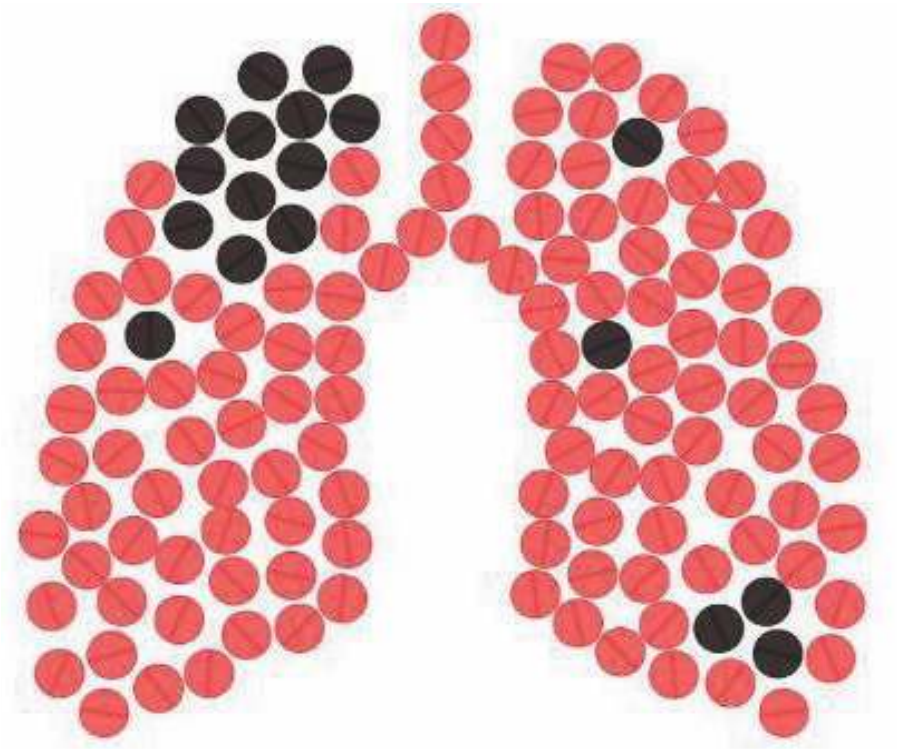
13.0 Suggestion for improvement :

To improve the status of Occupational Health Surveillance about Silicosis in Indian mines following suggestion are put forward for implementation in mining industry:

- Occupational Health Surveillance should be given top priority and should be part of the management's philosophy.
- Every mining company should set up structured Occupational Health Services with adequate manpower and facilities in line with recommendations of conference on Safety in Mines.
- Every mining company should formulate a comprehensive occupational health surveillance programme suitable to its specific occupational health problems for prevention of occupational diseases.
- Every mining company should computerize all records of medical and environmental surveillance.
- Every mining company should draw hazard exposure profile of individual workers for dust, noise etc.
- Every mining company should set up an integrated mechanism at company level to monitor occupational health surveillance programme.
- The proper infrastructure facilities for chest radiographs, lung function tests and classification of chest radiographs using ILO classification 2000 must be created. (refer DGMS (Tech) Circular No.05 of 2007).
- All chest X-rays of Initial and Periodical Medical Examinations should be classified in accordance with ILO Classification for detection, diagnosis and documentation of pneumoconiosis. Specifications of x-ray view box and viewing facilities in PME centers shall be improved and maintained as per the standard recommendation by ILO classification (refer DGMS (Tech) Circular No.04 of 2007).
- Manager of every mine must formulate and implement a sampling scheme for dust and noise measurement and analysis.
- Adequate facilities in the form of equipment and trained manpower should be created for environmental surveillance.
- The PME Medical Officer in every mining company should be a qualified Occupational Health Physician.
- Every Chest radiograph of Medical examination should be classified by PME Medical Officer trained in use of ILO classification.
- The workers vulnerable to silicosis needs to be made aware of the disease through wide publicity campaigns with the use of electronic and print media.

SILICOSIS - INCURABLE BUT PREVENTABLE OCCUPATIONAL LUNG DISEASE

Dr Swarupa Padhi
Senior Medical Officer NMDC Donimalai Complex



What is an Occupational Disease

A disease which occurs during the course of employment or after the employment and whose occurrence is directly attributable to the nature of occupation.

e.g. Silicosis, Coal Workers' Pneumoconiosis, Noise Induced Hearing Loss, etc.

Silicosis as Ancient Disease

- Detected among Mummies of workers in Egypt (1500 BC)
- Described by Hyppocrites as disease of metal miners (400 BC)
- Described by Kautilya in Arthshashtra (400 BC)

Silica

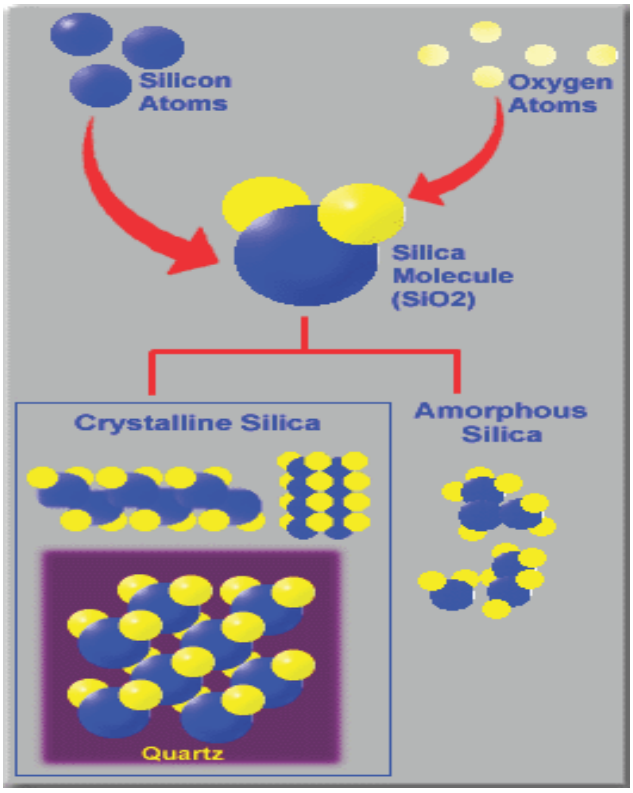
- Distribution of silica (SiO_2) is extensive in nature
- Earth's crust mostly consists of silica and silicates
- Silica is non-irritant and does not produce any immediate effects
- Large amount can be inhaled to produce serious consequences later
- Crystalline silica is the most fibrogenic substance found in nature

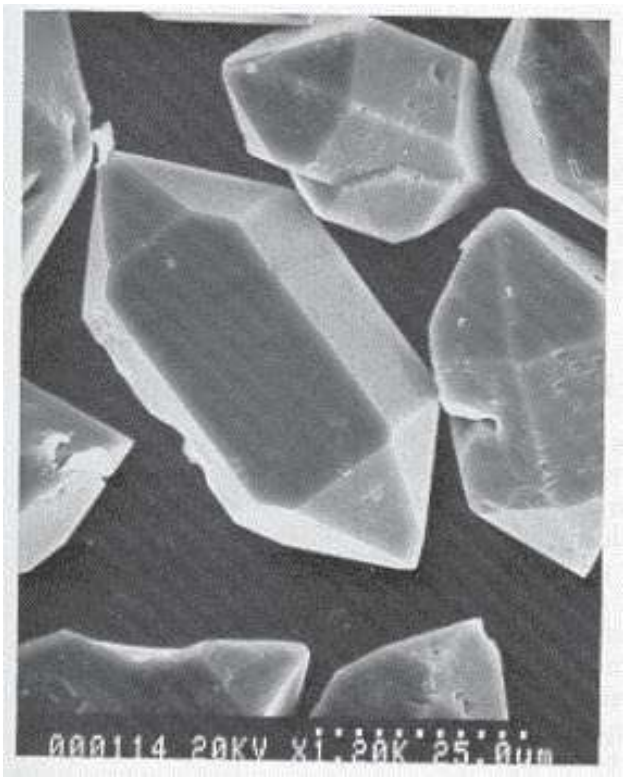
Manual Cutting in Stone Quarry

Drilling in Opencast Mine

Dry Drilling in Sandstone

SEM of Quartz Crystals

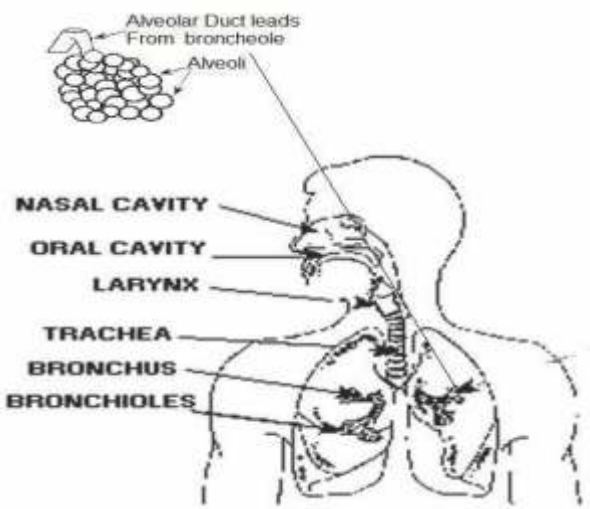




Deposition of dust in the system

- Dust-
- Inhalable dust-The fraction of airborne dust that enters the nose and mouth during breathing and is available for deposition in
- Respirable dust-The fraction of inhalable dust that penetrates into gas exchange region of the lung.size-0.1 to10micro meter.

Respiratory System



Defense of Respiratory System

1st Line – Filtration, Impaction and Sedimentation (Deposition)

2nd Line of Defense (Clearance)

– Mucociliary system

- Gas exchange region

– Alveolar fluid.

- Surfactants, IgG, IgA.

– Alveolar Macrophage

Deposition of Dust in Respiratory Tract

Naso-Pharyngeal 20-100 mm

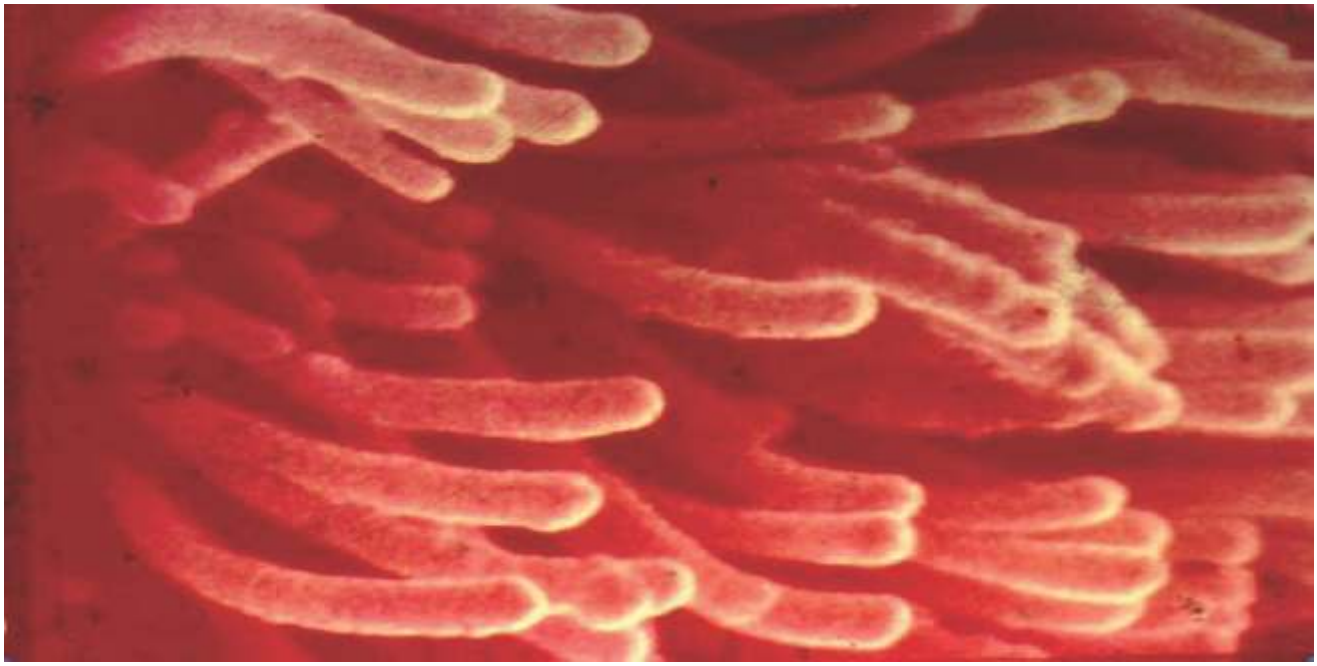
Tarcheo-Bronchial 3 - 20 mm

Alveolar < 4 mm

Mechanisms of Clearance of Dust

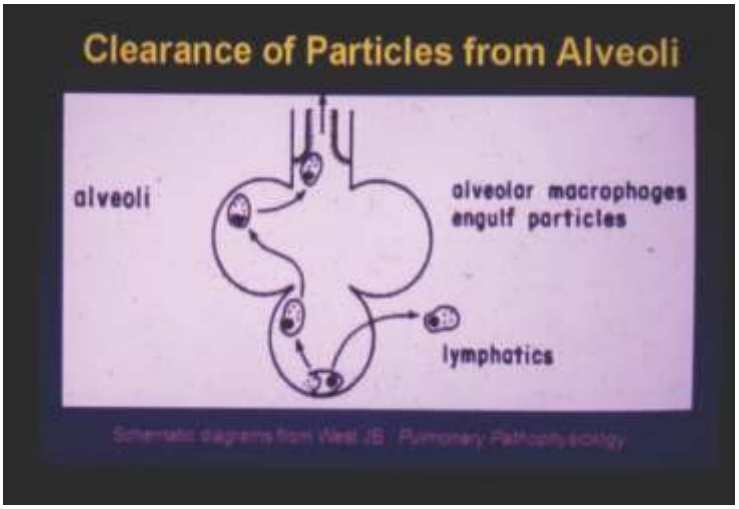
Muco-cilliary Transport

Phagocytosis



Electron-micrograph of ciliated epithelium of a normal young, healthy person.

Phagocytosis



Silicosis

- Silicosis is a type of pneumoconiosis caused by inhalation of crystalline silica dust
- Causes progressive permanent physical disability in advanced stage
- Occurrence is directly related to the degree of exposure to silica dust
- Freshly fractured silica dust is more toxic than aged dust
- Reactive radical groups on cleavage planes of freshly fractured moiety may be responsible for high toxicity

Pathogenesis of Silicosis

- Inhalation of respirable silica containing dusts
- Imbalance of dust retention and dust clearance
- Macrophage and tissue injury
- Silica particles phagocytosed by Alveolar Macrophases
- Release of chemotactic & inflammatory mediators
- Cellular response from lymphocytes and other cells
- Release of fibroblast stimulating factors
- Formation of hyaline nodule

Types of Silicosis

- Acute Silicosis
- Accelerated Silicosis
- Chronic Silicosis

Acute Silicosis

- Occurs within few months after massive exposure to fresh silica
- Presents as diffuse linear or rounded opacity in the lung fields.
- Presents as cough,breathlessness and later weight loss.
- Acute enlargement of hilar lymph nodes is common.
- Very poor prognosis, death due to hypoxemic failure

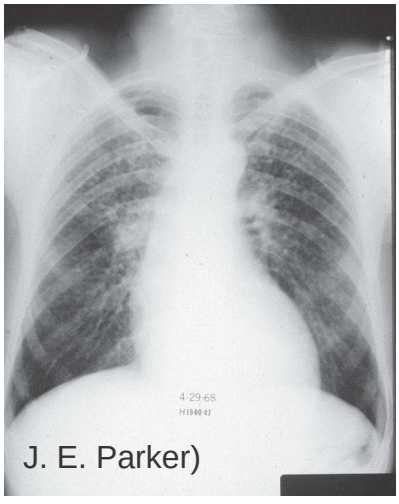
.Accelerated and Chronic Silicosis

- Accelerated silicosis occurs within 5-10 years of exposure
- Chronic silicosis normally occurs after 10-20 years of exposure
- Asymptomatic till onset of Progressive Massive Fibrosis
- Chest radiograph may detect silicosis in early stage
- Cough is an early symptom
- Breathlessness on exertion is the common symptom
- Tuberculosis is a common complication of acc. Silicosis.
- Typical bilateral nodular shadows on chest radiograph

Diagnosis of Silicosis

Key elements for diagnosis of silicosis

- History of exposure silica dust
- Chest x-ray with opacities consistent with silicosis
- HRCT
- Spirometry



J. E. Parker)

Simple Silicosis (Category 1)

Simple Silicosis (Category 2)

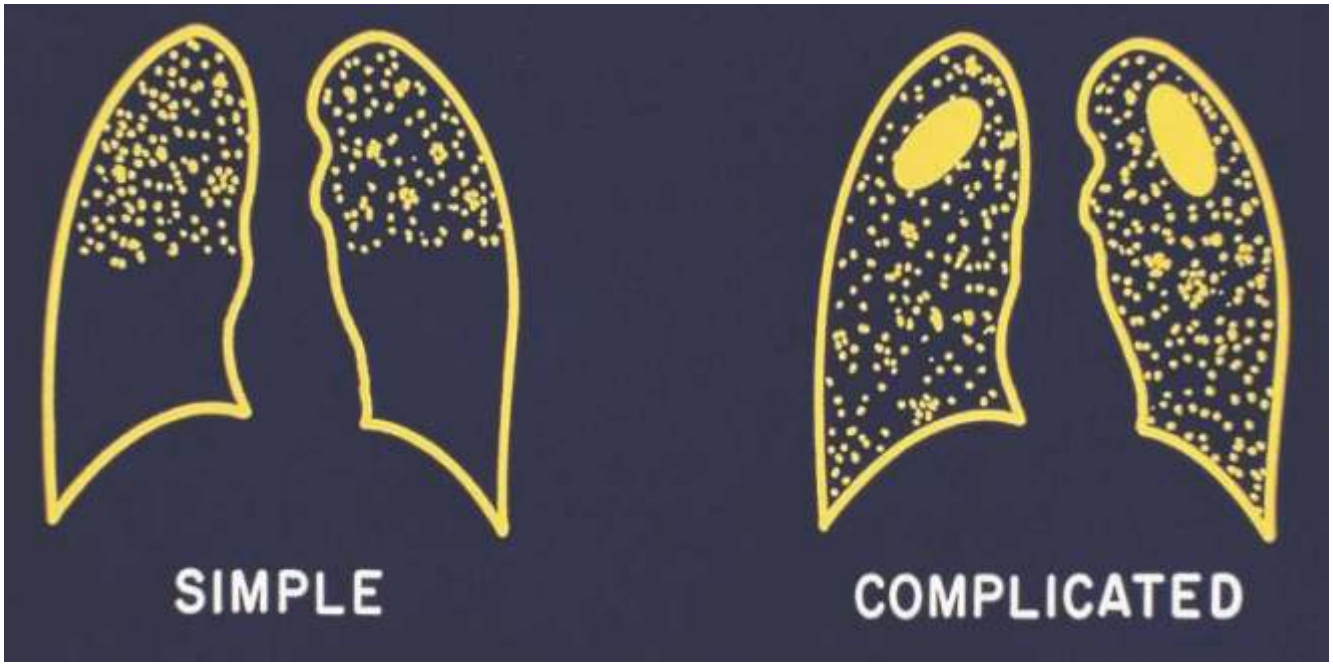
Simple Silicosis (Category 3)

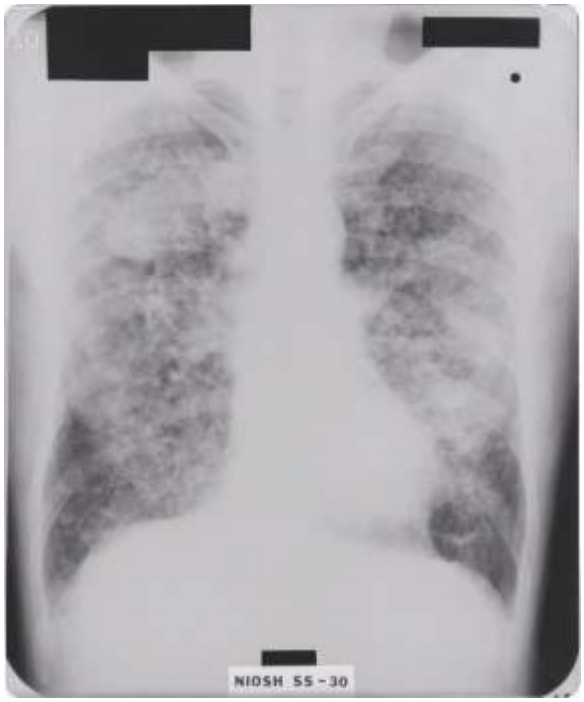
Silico-Tuberculosis

Stone Mine Worker, Karauli (2011)

Progressive Massive Fibrosis

- Small conglomerations (ILO category "A") in the upper zone
- Assymetrical
- Oval, round or sausage shaped
- No bronchopulmonary segments distribution

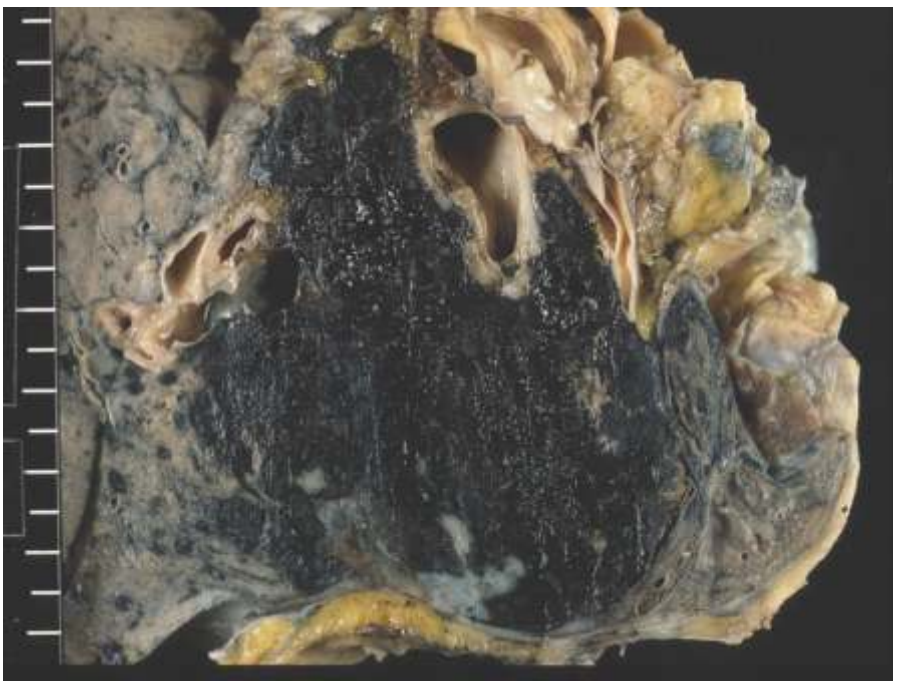




Silicosis with Progressive Massive Fibrosis

Classical Silicosis Courtesy Dr. Koich Honma

Progressive Massive Fibrosis in Silicosis Curtsy Dr. Koich Honma



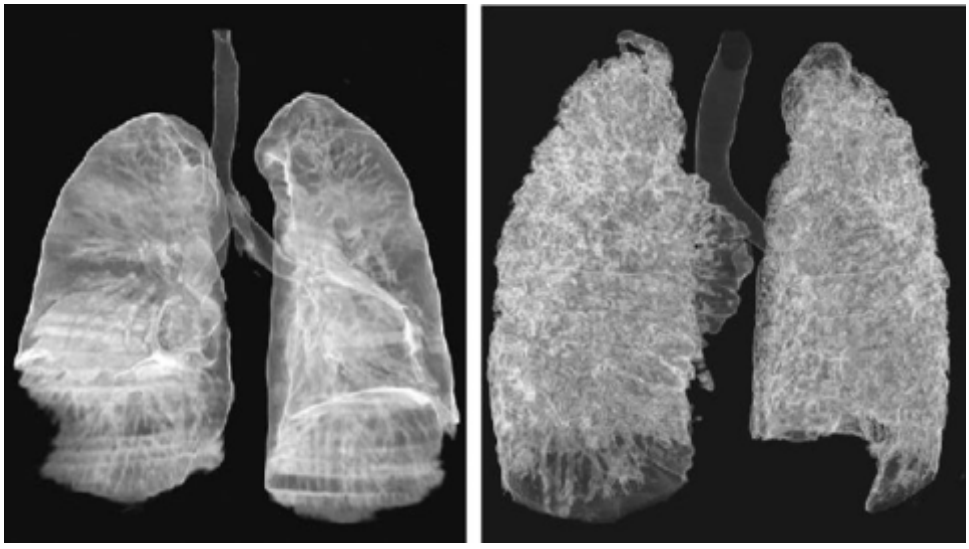
Progressive Massive Fibrosis Nodule in Silicosis Curtsy Dr. Koich Honma

Sensitisation of people about the disease

Silicosis is an irreversible disease hence prevention is the best way by identifying workplace activities that produce silica dust, eliminate or control the dust at the point of generation, regularly use PPE at the work place, job rotation and a healthy life style being some of the measures..Quit smoking since it plays a synergestic effect.

DUST IN INDUSTRY

Dr. Raviprakash K.C.
Sr. Medical Officer
M/s. JSW Steel Limited (OHC)



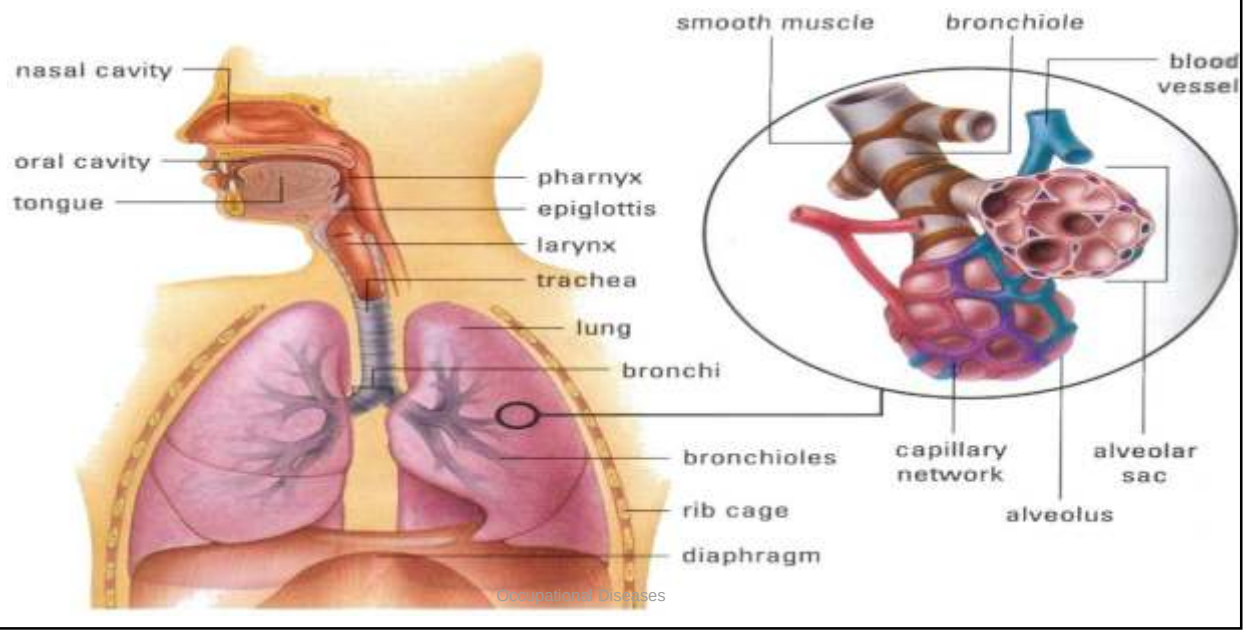
What is Dust?

• Fine, dry powder consisting of tiny particles of earth or waste matter lying on the ground or on surfaces or carried in the air.

Types of Dust

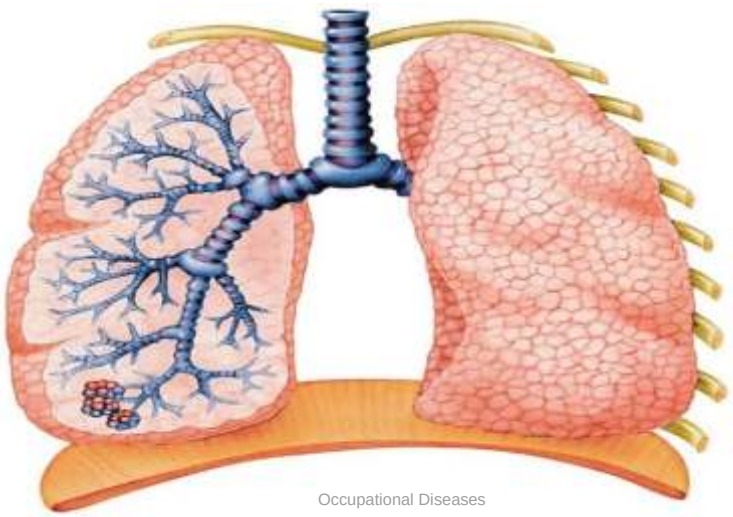
- Respirable dusts 0.5-5micron size (most dangerous)
- Non Respirable Dusts<0.5micron and > 5micron size
- Fibrosing dust:
- dust which retain in lung and cause fibrosis eg:- silica, asbestosis and coal dust
- Toxic dust: will be inhaled but not retained in lung but produce systemic effects eg:- cd, Ni, Cr, Pb
- Nuisance dust: those which either retained in lung or absorbed into system but without causing any damage eg:- chalk dust
-

Respiratory Tract



Functions of Lungs

- Exchange of oxygen and carbon dioxide between blood and air in the alveoli



Route of Entry to body

- Inhalation
- Ingestion
- Silicon dioxide, or silica, is the earth's most abundant mineral. Silica or free silica so called because it is not combined with other element. if it combines with other element it is called silicates
- Silicosis occurs when workers are consistently exposed to silica particles of respirable size (0.5–5.0 µm in diameter) at levels exceeding those recognized to be safe.
- Between 1968 and 1990 there were 13,744 deaths in the US where the death certificate mentioned silicosis.

SILICA (silicon dioxide)

FREE : 1.quartz (including granite)
2.flint
3.opal
4.diatomite.

Combined (silicates) :1.asbestos
2.talc
3.kaolin(white clay)

SILICON

- Earth's Crust has abundance of Elements in the Order of:-
- No.1 is O = 46.8 %
- No.2 is Si =27.8 %
- No.3 is Ca

Silica

Asbestos
$Mg_3Si_2O_5(OH)_4$

Kaolin : $Al_2Si_2O_5(OH)_4$

FREE SILICA

Crystalline form: 1. quartz (in sand and many rocks)

More fibrogenic

2. Cristobalite(when quartz is heated to1200℃)
3. Tridymite (600℃)
4. Coesite
5. Shistovite

naturally in e heating of quartz or lava and formed by the amorphous silica.

Amorphous form

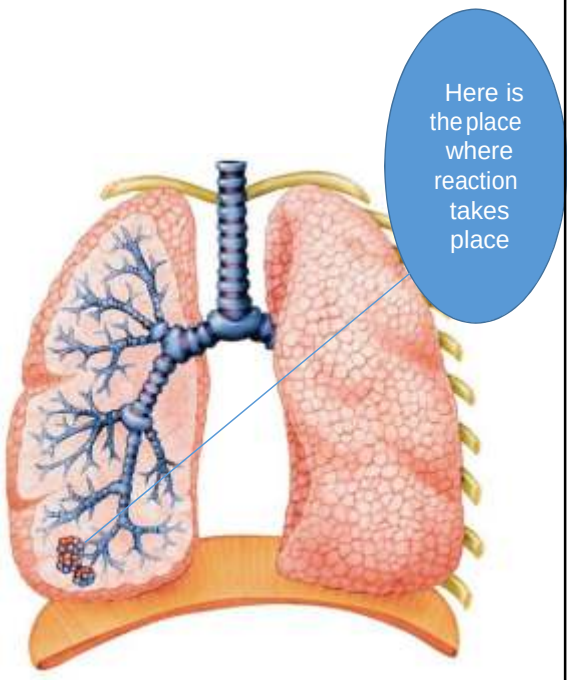
1.Diatomite (skeletons of marine organisms)

2.Vitreous silica (glass)

? Crystalline form silica are different in their structure, fibrogenicity, and biologic activity. More dangerous
? Amorphous silica is relatively less fibrogenic and does not cause lung fibrosis.

What is Silicosis

- Silicosis is your body's reaction to silica dust (free silica) build up in your lungs
- When you breath in silica, the tiny particles of dust settle deeply into your breathing passages. Scar patches form on your lung tissue. Scarring stiffens and damages your lungs, and this makes it hard to breathe.

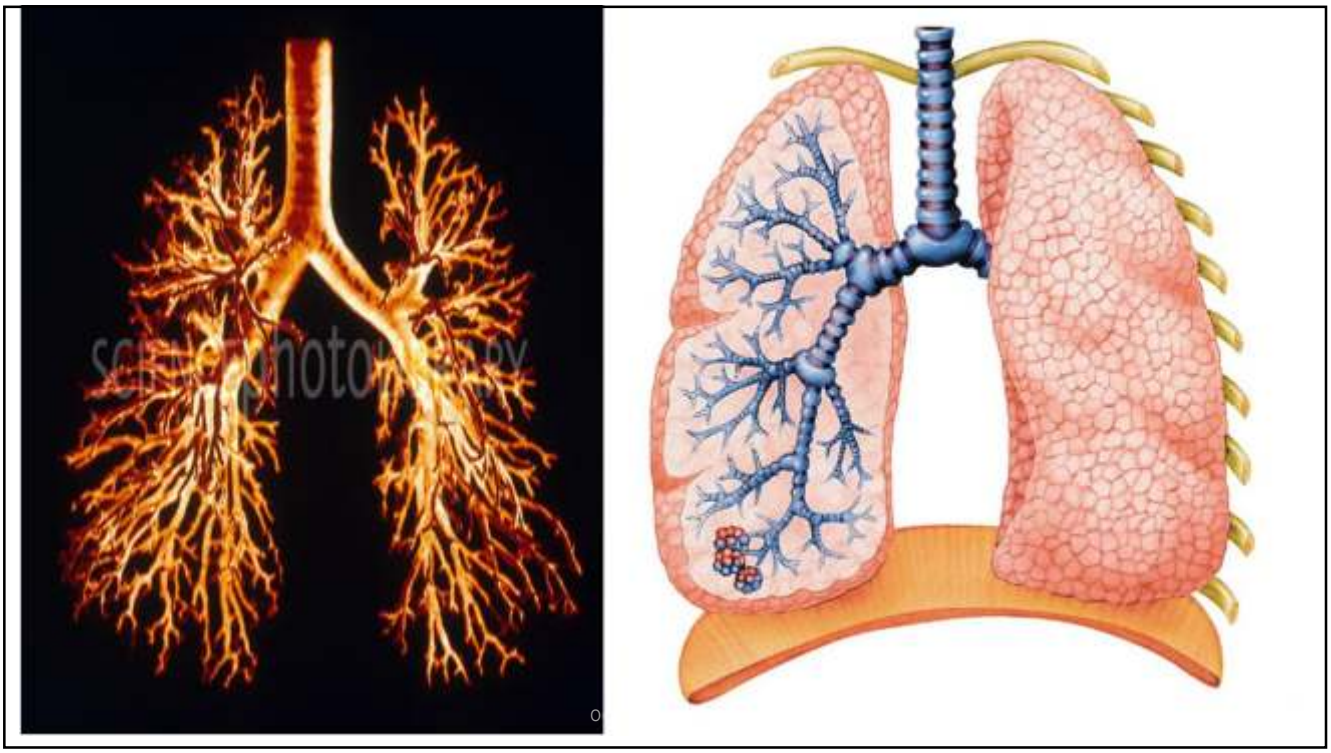


Who gets silicosis

Occupation	exposure
Mining	Silica contaminates the mined material
Milling	Dry, finely ground silica for abrasives and fillers
Quarrying and stone work	Slate,granite,sand stone exposure
Steel industry -industry-foundary work, boiler scaling furnace lining cleaners,	Silica as a mould fettling and chipping to make better moulded product, cleaning boilers may result in exposure to refractory bricks which has cloud of quartz
Sand blasting,	Ship building, oil rig maintenance,
Pottery making, Road repair ,masonry, Ceramic industries workers,Brick workers, Construction, Plaster or drywall installation	Crushed flint and fettling are major sources
Glass industry	Sand used to polish and as an abrasive


addtoheart
addtoheart

Exposure to Silica dust



? OSHA permissible exposure limit (PEL) is 100 µg/m3 for an 8-hour work exposure.

? Symptoms :

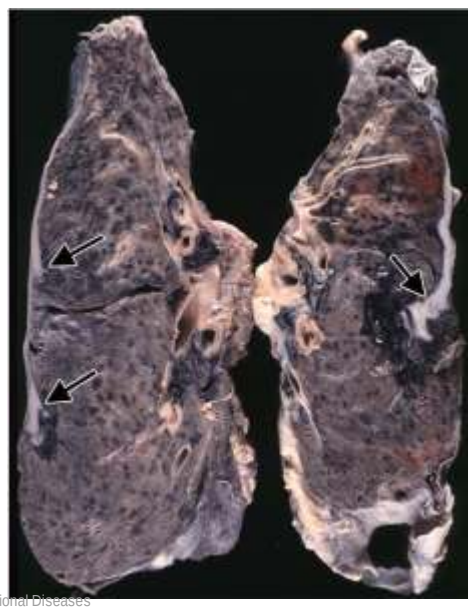
- Usually no symptoms in early stages
- Early signs are associated with smoking
- In late stages there may be dry cough
- Fatigue
- Breathlessness in advanced stage
- Respiratory (lung)failure

Types of silicosis

- Chronic silicosis: exposure usually >15yrs ,susceptible to TB
- Complicated silicosis:rapidly progress to respiratory failure. There is weight loss rapidly and breathlessness
- Accelarated silicosis:appear in more intense exposure for short duration of 5-10yrs symptoms are same as above but deterioration is rapid . Autoimmune diseases like scleroderma and rheumatoid arthritis are seen
- Acute silicosis:may develop within 6 months -2yrs of massive silica exposure severe dyspnea , wt loss are usual presenting symptoms usually death occurs within 1year

Silicosis – XRay

Silicosis – Silica dust



How Is Silicosis Diagnosed?

- tests to help diagnose silicosis include:
- PFT or Spirometry
- Chest X-ray or CT scan: This test checks your lungs for scars.
- Bronchoscopy: The doctor will run a long, thin tube with a tiny camera on the end into your lungs to check for damage.
- Biopsy: In a lung tissue biopsy, the doctor will guide a needle through your chest and into your lungs to take a sample of a nodule. She'll check it under a microscope for signs of silicosis.
- Sputum test: This will help evaluate other lung diseases, like tuberculosis.

Can Silicosis Be Prevented?

- The simplest steps include: employee responsibility
- Limit the time you're exposed to silica.
- Wear a mask or other protective clothing while you work around it.
- Don't eat or drink near silica dust
- Wash your hands and face before you eat.
- Shower and change clothes after work
- Avoid smoking

Preventive measures for Dust by employer

Your employer is required to provide proper safety equipment. Other ways to prevent silicosis on the job:

1. Use blasting cabinets or proper ventilation.
2. Use wet methods to cut, chip, or grind materials.
3. Swap blasting material that contains silica for other types.
4. Remove any residual Dust by proper Ventilation and vaccum suction
5. Prevent workers entry until cleared by Ventilation
6. Air conditioned cabin for crane operators, drivers. Etc
7. Monitoring of Free silica, coal and Respirable Dust

ASSESMENT OF EXPOSURE

- Air Sampling at fixed locations by
- Membrane filters
- Impingers
- Thermal precipitators
- Konimeters
- Preferred method is by PERSONAL AIR SAMPLING using membrane filter
- Quantification possible by
- X-ray diffraction, infrared spectrometry.
- Electron microscope used to count fibers.

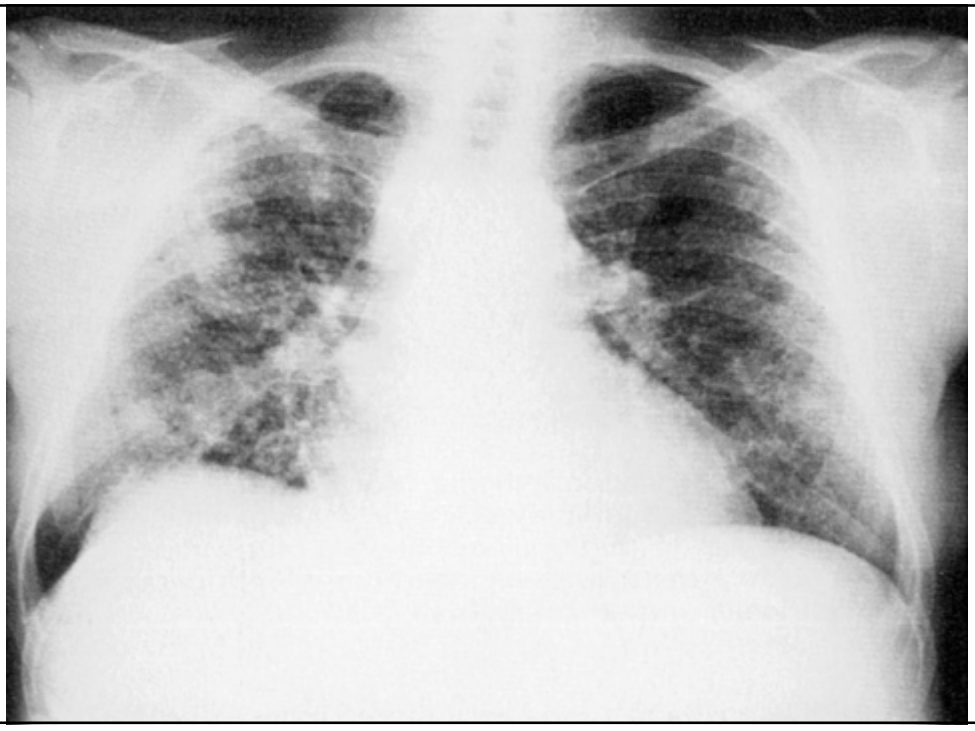
Treatment

- There is no treatment for silicosis
- Only prevention
- How Is Silicosis Treated?
- There's no cure for silicosis right now. Treatments can help you manage your symptoms.
- Medications
- Inhaled steroids reduce lung mucus.
- Bronchodilators help relax your breathing passages.
- Oxygen therapy
- This small, portable tank gives you extra oxygen to help reduce fatigue.
- Lung transplant surgery
- You may need this if you have advanced lung damage.
- One major lifestyle change can help you manage this disease:
- Stop smoking: It's dangerous if you have silicosis. It makes your lung damage even worse.

Case 1

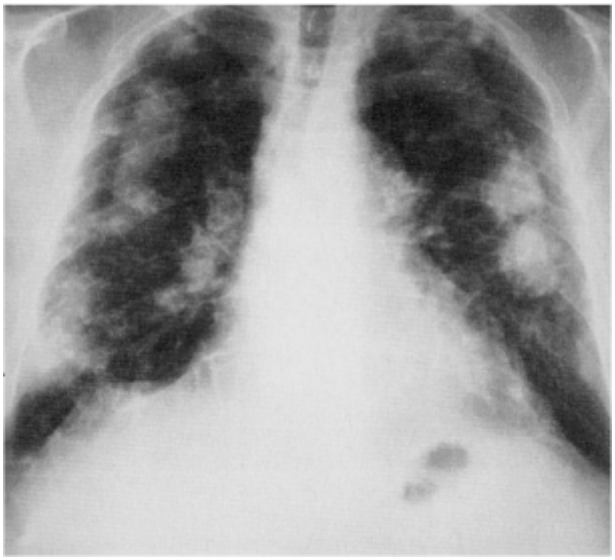
Chest radiograph from a 56 year-old man taken 7 years after ceasing employment at a silica flour mill where he had been employed for 6 years as a bagger. He complained of symptoms of dyspnea and chronic bronchitis.

He had an 8-year smoking history. Spirometry showed borderline restriction. The chest radiograph showed profuse small rounded opacities and progressive massive fibrotic lesions in the right upper and mid- zones.



Case 2

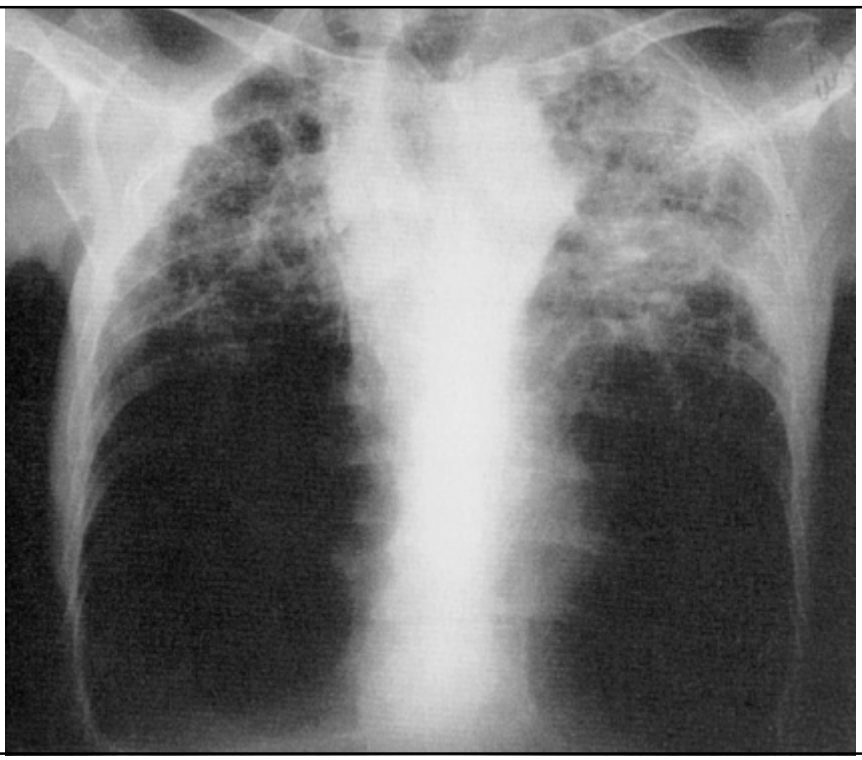
CX-Ray from a surface mine driller. smoked heavily for many years. Asymmetric bilateral upper zone progres-sive massive fibrotic lesions are present. larger and denser left sided mass lesion raises concern of a pulmonary maligna ncy.



Case 3

? Chest radiograph from a worker employed for many years in a glass factory with silicosis who then experienced a relatively aggressive downhill course.

? Investigation revealed infection with M. tuberculosis. Although he responded to multiple drug therapy, he still had severe progressive massive fibrosis, extensive emphysema, and impaired function.



Silicosis – Prevention is better than cure

Sri D.P. Mukhopadhyay
Sr. G.M.(Mines), Rajashree Cement Limestone Mine
M/s. UltraTech Cement Ltd.
Malkhaid Rd., Kalaburagi (Karnataka)

Introduction:

Most mining operations produce dust which when airborne becomes a serious hazard to the health of workers. With introduction of mechanisation both in opencastand underground mines, it has become a bigger danger than ever before since operations ofmachines usually throw up much more dust as compared to hand operations. Dust of any kind ofsufficiently fine quality when inhaled in large quantities may lead to development of respiratorydiseases such as pneumoconiosis and silicosis etc. There are adequate regulatory provisions in Mine Act 1952 under various regulations & guidelines for protection of resirable diseases connected with mining operation. However, due to irresponsible attitude of mine operators and lack of systematic detection / monitoring system, Silicosis has become a cause of one of the most prominent Occupational Health Hazards. The gravity of the situation was first pointed out by National Human Rights Commission, who reported that large number of quarry workers in Jhabua & Alirajpur Districts of Madhya Pradesh and Godhra of Gujrat died due to silicosis. The matter subsequently was referred to and disposed of by Hon'ble Supreme Court of India. While disposing the case, many other states were included where similar activities exists, posing a threat of Silicosis and various directives were issued to the State Govt. authorities, State and Central Pollution Control Boards as well as DGMS, vide order dated 23.8.2016 against WP No. 110/2006. DGMS has since carried out Silicosis Awareness Programs at various levels. The concern is that the disease is not detectable at initial stage. Once affected, there is no cure for this disease, thus, prevention is the only answer and mine operators should take outmost care in prevention of the disease.

What is Silicosis:

Pneumoconiosis is a general name for a number of dustrelatedlung diseases which includes Silicosis – Silicosis is a form of pneumoconiosis, a disease of the lungs due tobreathing of dust containing silica

particles. Silica dust can cause fibrous or scartissue formations in the lungs which reduce the lung's ability to work, extract oxygenfrom the air. For the purposes of occupational hygiene, it is important to consider the concentrations ofdust present in different size fractions.

(a) Inhalable Dust – It is the fraction of airborne dust that enters the nose and mouthduring breathing, and is therefore available for deposition in the respiratory tract.

(b) Respirable Dust – It is the fraction of inhalable dust that penetrates into the gasexchange region of the lung. It is mostly in the size fraction of 0.1 to 10 um.

There are several stages of pneumoconiosis/ silicosis. Early stages may go completelyunnoticed. Continued exposure may result in the exposed person noticing a shortness ofbreath upon exercising, possible fever and occasionally bluish skin at the ear lobes or lips.Pneumoconiosis or Silicosis makes a person more susceptible to infectious diseases of thelungs. Progression of the disease leads to fatigue, extreme shortness of breath, loss ofappetite, pain in the chest cavity which all may lead eventually to death. Acutepneumoconiosis or silicosis may develop after short periods of exposure. Chronic silicosisusually occurs after 10 or more year of exposure to lower levels of quartz.

What is the prescribed limit:

In India, the maximum exposure limit (MEL) is prescribed as 3 mg/m3 for eight hour's time weighted average, provided the concentration of silica in the respirable dust remains less than 5%. In case the %of Silica content in the respirable dust exceeds 5%, the MEL is calculated to be 15 divided bythe % of Silica content in the respirable dust. Regulation 123 of the Coal MinesRegulations, 1957 as well as regulation 124 of the Metalliferous Mines Regulations, 1961clearly specify provisions therefore.

However, in most of the cases, it is reasonably practicable to control exposure to0.1mg/m3 (8 hours TWA) or less by engineering or process control.It has been advised by DGMS that mine management should ensure that the workers are not exposed torespirable crystalline silica dust concentrations above this level. If exposure cannot becontrolled to 0.1mg/m3 (8-hours TWA)or below, by elimination, engineering or processcontrol, then the exposure must be controlled by provision and use of suitable respiratoryprotective equipment as provided under sub regulation (4) of regulation 123 of the Coal MinesRegulations, 1957 and that of the Metalliferous Mines Regulations, 1961.

The risk of developing silicosis is closely linked to the accumulated exposure of an individual to crystalline silica during their working lifetime. Exposure can be calculated as follows:

It is important to remember that while exposure is significant, it is not entirely determinant, many workers do not fit the dose–response pattern. Some individuals are particularly sensitive to low doses, while others can tolerate high exposure levels. The susceptibility to the disease is associated with the build-up and persistence of inhaled dust in the body, due to inefficient defence systems and clearance mechanisms that may be affected by genetic or other factors, such as smoking or chronic obstructive pulmonary disease (COPD) or other respiratory diseases. Some risk factors for disease progression have been identified, including high levels of exposure, previous history of tuberculosis, and profuse opacities on imaging studies.

What is ILO international classification of radiographs of pneumoconiosis:

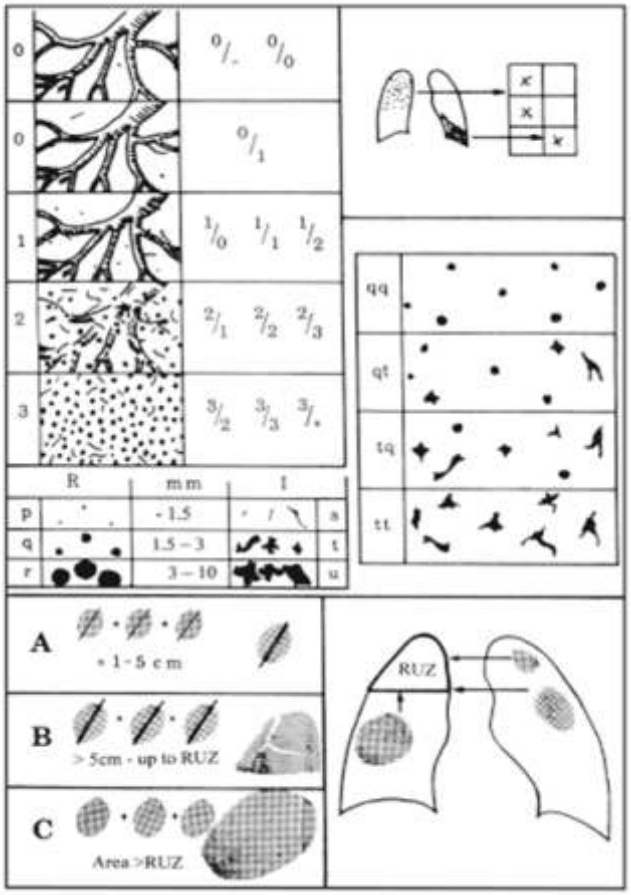
The ILO Classification system includes the printed Guidelines and sets of standard radiographs, available in both film and, as of 2011, digital forms. The reader compares the subject chest X-ray (only the appearances seen on postero-anterior, or PA, chest x-ray) with those of the standard set. The standard radiographs provide differing types ("shape and size") and severity ("profusion") of abnormalities seen in persons with pneumoconiosis. The ILO Classification system pertains to pulmonary parenchymal abnormalities (small and large opacities), pleural changes (pleural plaques, calcification, and diffuse pleural thickening) and other features associated, or sometimes confused, with occupational lung disease.

Parenchymal Abnormalities:

Small Opacities: The reader will categorize small opacities according to shape and size. The small, rounded opacities are p (up to about 1.5 mm), q (about 1.5 mm to about 3 mm), or r (exceeding about 3mm and up to about 10 mm). Small, irregular opacities are classified by width as s, t, or u (same respective sizes as for small, rounded opacities).

Large opacities: A large opacity is defined as any opacity greater than 1 cm in diameter. They are classified as Category A (for one or more large opacities whose combined longest dimension does not exceed about 50 mm), category B (for one or more large opacities whose combined longest dimension exceeds 50 mm but does not exceed the equivalent area of the right upper lung zone), or category C (for one or more large opacities whose combined longest dimension exceed the equivalent area of the right upper lung zone).

Profusion: Using the Standard X-rays, the profusion (concentration) of small opacities is classified on a 4-point major category scale (0, 1, 2, or 3), with each major category divided into three, giving 12 ordered subcategories of increasing profusion: 0/-, 0/0, 0/1, 1/0, 1/1, 1/2, 2/1, 2/2, 2/3, 3/2, 3/3, and 3/+. Category 0 refers to the absence of small opacity and category 3 represents the most profuse. The major category (first number) represents the profusion felt to best fit the subject x-ray, and the minor category (second number) represents either the profusion seriously considered as an alternative, or if none, the same profusion as the major category. For example, if the reader thinks the x-ray being read has profusion most like the standard x-ray for category 1, but serious considered category 2 as an alternative description of the profusion, then the reading is 1/2.



Lung Zones: Each lung is mentally subdivided by the reader into 3 evenly spaced zones: upper, middle, and lower. The zones in which the small parenchymal opacities appear are recorded.

Pleural Abnormalities: Pleural abnormalities are reported with respect to type (pleural plaques or diffuse pleural thickening), location (chest wall, diaphragm, or other), presence of calcification, width (only of in profile pleural thickening seen along the chest wall edge), and extent (combined distance for involved chest wall).

Any Other Abnormality: There are 29 "obligatory" symbols representing important features related to dust diseases of the lungs and other etiologies.

Silicosis Prevention Measures:

The following has been prescribed by DGMS vide Circular No. 01 dated 21.01.2010 and 21.01.2011:

(a) The concentrations of dust and crystalline silica content therein should bedetermined for the strata encountered during drilling in Overburden Benches andalso for every coal seam in the mine.

(b) Wherever there is change in the strata condition, the same measurements shouldbe done at such places also.

(c) In underground workings, the concentration of respirable dust should also bedetermined while drilling in the floor as well as into the roof up to a level/depth whichare required to be used for roof bolting, cable bolting or for any other purpose.

(d) Dust Measurements should invariably be done while using new drill bits/picks andwhile rejecting the bits/picks so as to know the dust generation profile of the drillmachines/Continuous Miner or any other cutting Machine.

(e) The Medical Examination of Identified persons or Group of Persons working at places or operations/processes prone to generate airborne dust should be conducted once in every Six Months and the Results of such medical examinations should be correlated with the dust exposure profiles of that place(s) and or process(s).Health assessment for workers exposed tosilica dust should include the following :-

a. A history should be taken coveringthe worker's occupational exposure to dust containing silica;

b. any past or present medical diagnosis of respiratory disease; and

c. the worker's smoking history.

d. A clinical examination should be carried out on the respiratory tract system. Aspirogram (Pulmonary Function Test) should be carried out including determinations of forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV1).

e. Sputum examination for Tuberculosis once in every year.

f. A Single posterior-anterior chest X-ray should be done every 5 years on workers without signs of silicosis or other pneumoconiosis and every 3 years on workers who do have X-ray changes. All chest radiographs should be classified according toInternational Labour Office (ILO) Classification of Radiographs of the Pneumoconiosis, 2000.

g. Initial medical examination should be conducted for all mining workers whether permanent, temporary or contractual, before they are engaged in any mining job.This include a single posterior-anterior chest X-ray and A spirogram (PulmonaryFunction Test) should be carried out including determinations of forced vital capacity(FVC) and forced expiratory volume at 1 second (FEV1).

(f) During the conduct of Medical Examination of such select persons or group of persons, an Officer of Occupational Health Wing from this Directorate should also be called as an external member.

(g) Apart from the above, an independent team of Medical Experts on Pneumoconiosis and Silicosis may be formed by selecting doctors from outside the companies and such team should be entrusted with the work of medical examinations at least once in every year for the above purpose independently. The Reports of medical examinations of such independent team should be submitted to this Directorate at the end of every year.

(h) In case, a person is found to be affected with Pneumoconiosis or silicosis, the details regarding his work profile, degree of disability, medical history and expenses, compensation and the status of health and

rehabilitation measures taken by the company etc. should be sent to this Directorate immediately in the prescribed Format.

(i) Suitable Training Module for imparting training to Medical Officers engaged in conducting medical examinations for identification of Silicosis/ Pneumoconiosis as per the ILO Classification of Chest Radiograph shall be prepared and conducted once in every year so that the Medical Officers are adequately trained and equipped to identify the cases of Silicosis/ Pneumoconiosis without any doubts or ambiguity.

Once detected with Silicosis, immediate steps should be taken by the management for the patients' change of work i.e. giving some alternative job which has minimum dust exposure, providing adequate treatment and compensation as per applicable laws.

Snapshots of preventive measures being taken at Rajashree Cement Limestone Mine:

Inbuilt Wet drilling mechanism

Wetting of Blasted Muck pile

Dust suppression on Haul Road

Water spraying on crusher dump hopper

Air cleaner cleaning hopper

Full-fledged medical facility with trained medical professional for ILO classification

Personal respirable dust sampling at crushing plant

Personal respirble dust sampling at drilling site

drawn for free silica analysis. Those two free silica samples were purposely drawn without sprinkling water and by drydrilling.

- The drill machine dry drilling dust suppressor was not functional on the day of sampling.

2.4.1. Rajashree Limestone Mine

- The area respirble dust sampling was conducted at six (N=6) different working locations revealed, that the equivalent MRE TWA respirable dust concentration in sampled location. All the area respirable dust samples recorded a dust concentration below the permissible limit value of 3 mg/m^3. Two samples drawn for free silica analysis without sprinkling water and by dry drilling as instruction of NIMH scientist revealed dust concentration above TLV. However this two samples was drawn exclusively for free silica analysis and not for monitoring respirable dust in the mine.
- The area respirable dust concentration in two crushing plants 2.53 to 1.52 mg/m^3 and in crusher haulage Road junction 2.57 mg/m^3. The area dust concentration during loading of dumper was 1.47 mg/m^3.
- The personal respirable dust sampling was undertaken on four (04) different categories of workmen. The respirable dust exposure of drill operator was 1.91 mg/m^3 Rock breaker operator was 1.95 mg/m^3, and crusher helper/cleaner was 1.20 & 2.37 mg/m^3 respectively. The personal respirable dust concentration ranged from 1.20 mg/m^3 to 2.37 mg/m^3 with a mean personal respirable dust conc. of 1.86 mg/m^3. All the personal respirble dust samples recorded a dust concentration below the permissible limit of 3 mg/m^3. The field average dust concentration for Rajashree Limestone Mines of Ultra Tech Cement Ltd., Malkhed is 1.93 mg/m^3.

2.5 Conclusion & recommendation

- All the respirable dust samples collected from the mines were within the TLV of 3 mg/m^3.
- The UTCL management may continue the present respirable dust management strategy to control the area & personal dust concentration of this mine. Fogging technique and regular cleaning of all crushing plant may be introduced at all under ground belt conveyor junction points.
- The Atlas Copco drill machine may be fitted with company supplier make dust suppressor suction unit for dry drilling operation. At present that dust suppressor unit has been removed from drill machine.

- Each and every employee of the mines undergoes Six monthly lung function test and audiometry test.
- Nose mask is a mandatory PPE for all the persons working in mines as per Safety Standards of UltraTech Cement Limited.
- Historical PME reports in hard copy is maintained at hospital and also digitized reports.
- Comprehensive Dust monitoring scheme has been prepared and implemented.
- Apart from water spraying in dump hopper of crusher, adequate capacity bag filter has been provided in enclosed crushing chamber

All the HEMMs and Drilling machines are equipped with AC operator cabins.

Conclusion

It is likely that many people worldwide who are exposed to silica dust in their workplace are unaware of the very real danger it poses. It is also possible that many employers are not aware of the risk. Education is therefore key in any global or national effort to combat the condition. The onus is thus left with the industries for creating awareness amongst the workers regarding danger of Silicosis and its prevention & monitoring mechanism.

Silicosis Awareness

Sri Y. Rama Mohan Reddy
V.T. Manager, C.N.Halli.

Concept of Occupational Health Hazards;-

- Any health problem of worker which is related to his work.
- Occupational health-Refers to total health of the worker
- Occupational disease- Disease directly caused by person's occupation
- Occupational Health may be defined as the state of –
- Physical -
- Mental -
- Social and -
- Spiritual –
- Well being of all workmen at all kind of workplaces and not merely absence of sickness and infirmity-

Occupational Health hazards (Broad Classification)

Physical Hazards -Dust, Noise, Vibration, Temperature, Illumination.

Chemical Hazards - Metals and other inorganic substances. Organic substances. Gases like CO, CO2, SO2, Methane

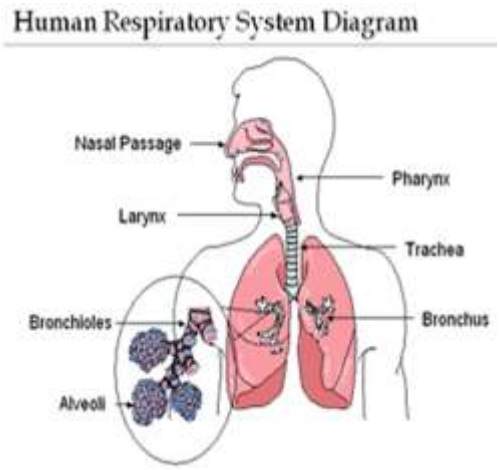
Mechanical Hazards - Hazards due to operation of various machineries.

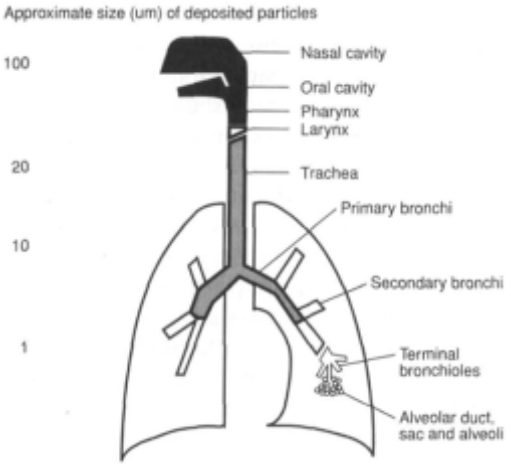
Biological Hazards - Micro-organisms, Insects, Snakes, etc.,

Psychological Hazards - Job dissatisfaction, low morale, tension, anxiety etc.,

Defining the Dust;-

- Dust is generally understood to be an aerosol of solid particles of size 0.1µm and above
- Inhalable Dust - It is the fraction of airborne dust that enters the nose and mouth during breathing. And is therefore available for deposition in the respiratory tract
- Respirable Dust – It is the fraction of inhalable dust that penetrates into the gas exchange region of the lung. It is mostly in the size fraction of 0.1 to 10 µm





EXPOSURE LIMITS AIR-BORNE DUST;-

- DGMS (TECH)CIR.5 OF 1987
- CIRCULAR RECOMMENDS THAT THE AVERAGE CONCENTRATION OF RESPIRABLE DUST IN MINE ATMOSPHERE DURING EACH SHIFT TO WHICH EACH MINER EXPOSED for 8 hours AT ANY WORKING POINT OR PLACE SHALL NOT EXCEED 3 MG/M3 WHERE THE FREE SILICA IN AIR-BORNE DUST IS 5% OR LESS –

EXPOSURE LIMITS AIR-BORNE DUST;-

- WHERE THE DUST CONTAINS MORE THAN 5% QUARTZ OR FREE SILICA , THE LIMITING IS DETERMINED BY THE FORMULA :

PERMISSIBLE CONCENTRATION OF AIR-BORNE DUST. –

❖ $= \frac{15}{\%\ \text{RESPIRABLE QUARTZ OR FREE SILICA}} = \text{MG/M3},$

Sources of dust generation; - Dust is generated from a varied number of operations at mines such as,

- Excavation work
- Loading
- Transportation / Haulage
- Unloading
- Screening
- Ore beneficiation operation etc.,
- Drilling & Blasting
- Rock crushing
- Drilling and blast hole cleaning
- Waste dumping and Backfilling

Effects of dust;-

- Silica – Silicosis
- Iron – Siderosis
- Manganese – Manganese poisoning
- Asbestos – Asbestosis
- Coal dust– Coal miner's Pneumoconiosis

Notified diseases Section 25 of Mines Act;-

- Silicosis –
- Pneumoconiosis
- Manganese poisoning – Nervous type
- Asbestosis –
- Cancer of Lung or the stomach or the Pleura and Peritoneum
- Siderosis –

Statutory provisions Mines Act 1952 . Sec 25 Notice of Certain Disease:-

– Where any person employed in a mine contacts any disease notified by the Central Government in the official Gazette as a disease connected with mining operations the owner, agent or manager of the mine, as the case may be, shall send notice thereof to the Chief Inspector and to such other authorities in such form and within such time as may be prescribed

– If any medical practitioner attends on a person who is or has been employed in a mine and who is or is believed by the medical practitioner to be suffering from any disease notified under sub-section(1) the medical practitioner shall without delay send a report in writing to the Chief Inspector

MMR 1961 Reg.10 Notice of disease;-

• Where any person employed in a mine contacts any disease notified by the Central Government in the official Gazette as a disease connected with mining operations the owner, agent or manager of the mine shall within 3 days of his being informed of the dieses send notice thereof in form v of first schedule of the district magistrate, the Chief Inspector, Regional inspector of the mines and Inspector of mines (Medical)

Mines Rules 1955;-

• Rule 29A Medical examinations of persons employed or to be employed in mines who are employed purely on temporary or casual basis for a continues period not exceeding six months.

• 29 B Initial and Periodic medical examinations –

• The owner, agent ,manager of every mine shall make arrangements

• For the initial medical examination of every person seeking employment in the mine –

• For the periodical medical examination thereafter of every person employed in the mine at intervals of not more than Five years

10TH SAFETY CONFERENCE RECOMMENDATION: dated 21.02.2011

• Initial medical examination shall be made mandatory for all mining employees whether permanent, temporary or contractual , before they are engaged in the mining job

• The frequency of periodical medical examinations should be brought down from the existing five years for the mining

employees above 45 years of age. This should be implemented in three years.

DGMS (Tech.) Circular No.01 Dhanbad Dated 21.01.2010;-

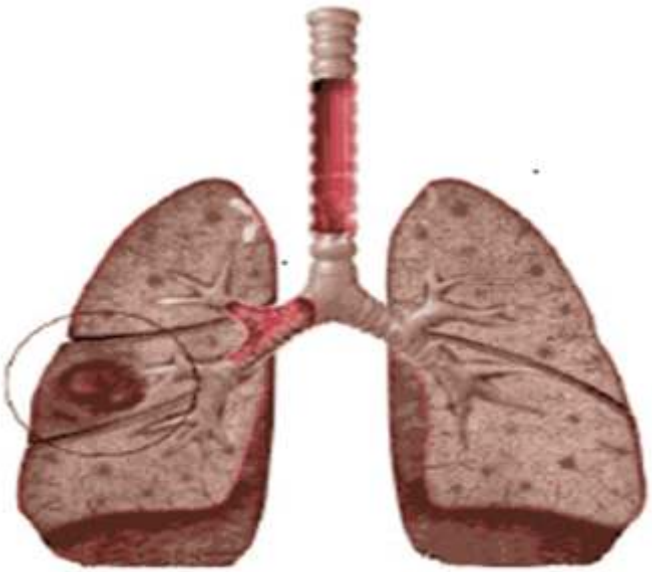
• Respirable Dust Measurements and Control to Prevent Pneumoconiosis in Mines.

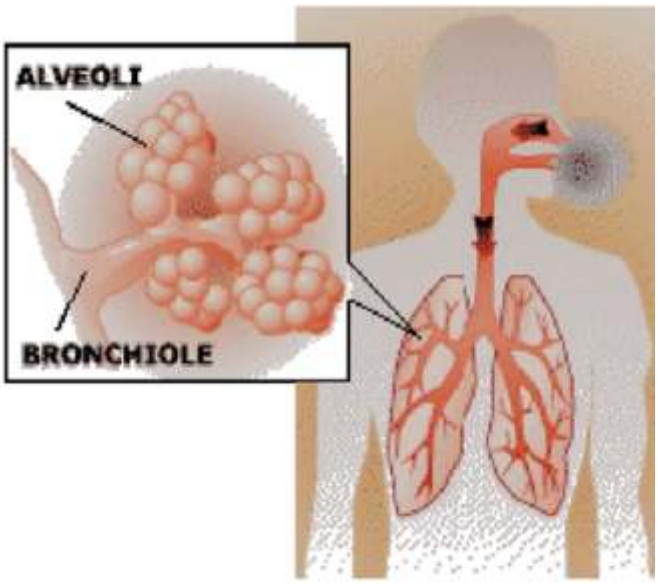
• It is to bring the notice of all concerned that an integrated effort is being made by the Government of India to significantly reduce the Pneumoconiosis/ Silicosis by 2015 and to totally eliminate pneumoconiosis/ Silicosis at workplaces by 2030 in line with the International Labor Organisation (ILO) and the World Health Organisation (WHO) Global Programme for the Elimination of Silicosis.

What Is Silicosis;-

• Excessive or long-term exposure to harmful respirable dust may result in a respiratory disease called…… Pneumoconiosis. Pneumoconiosis is a general name for a number of dust – related lung diseases including _ Silicosis

• Silicosis- Silicosis is a form of Pneumoconiosis, a disease of the lung due to breathing of dust containing silica particle. Silica dust can fibrous or scar tissue formation in the lungs which reduce the lung's ability to work, extract oxygen from the air There is no cure for this disease, thus, prevention is the only answer.



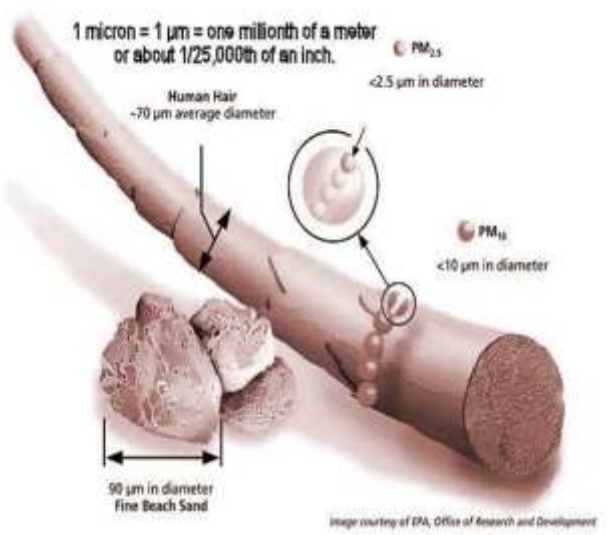


• Silicosis is a slow, progressive, occupational, irreversible pulmonary lung disease that usually occurs, after many years of exposure with fine respirable crystalline silica particles (RCS).

• Silica is the most common mineral in the earth's crust and is a major component of sand, rock, and mineral ores.

Size of the Dust;-

- A micron is one millionth of a meter
- Human hair varies between 40 to 100 mm thick
- Respirable dust = 10 mm or less



Industry wise prevalence of silicosis in India

15/22

Industry	Prevalence(%)	Reference
Gold Mines	9-14	Caplan, Gowda
Mica Mines	34	CAF
Lead & Zinc	30.4	CAF
Stone Cutter	35	Gupta
Foundry	27	Samel
Slate Pencil	54	Saiyed
Stone quarry	22	NIOH
Sand Grinding	28	NIOH
Ceramics & potteries	15	Saiyed

ICMR

Major industries with silica exposure;-

- Mining: Drilling, Blasting, Hauling and Crushing
- Sandblasting
- Glass making-
- Crushing and drilling rock
- Masonry and concrete work
- Tunneling, demolition works
- Cement and asphalt pavement
- Manufacturing





TYPES OF SILICOSIS;-

- Acute silicosis: occurs with exposure to fine dust with high quartz content; very heavy exposure for months, shows symptoms within weeks to months of exposure,
- Accelerated silicosis: shows rapidly progressive symptoms after 5 to 10 years of high exposure to fine dust of high silica content.
- Chronic silicosis: the most common form, results from long –term exposure (10 to 20 years or longer) to dust containing less than 30% silica content.

Silicosis Depends On;-

- The amount and kind of dust inhaled
- The Percentage of free silica in the dust
- The form of silica
- The Size & Shape of silica particle
- The duration of exposure
- The Individual's natural body resistance
- The presence or absence of complicating factors (such as infection vectors).

SYMPTOMS OF SILICOSIS;-

DETECTION OF SILICOSIS;-

- Early detection is difficult-
- Absence of Symptoms
- Radiography-X ray of chest (Shows fibrous tissues)
- Work History – Helps differentiating Silicosis with other dust causing disease such as

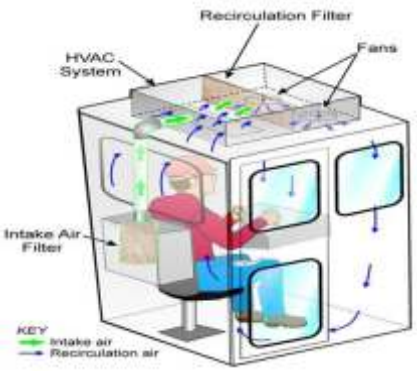
Asbestosis

- Lung function test using spirometer

Prevention of Silicosis;-

Minimise exposure to dust

- Encourage Mechanisation, and ensure less deployment of manpower in dust generating areas.
- Strict enforcement of effective Dust Masks in dusty areas.
- Persuasion for more deployment of HEMMs with closed operators cabins



Estimation of Dust exposure;-

- DGMS guidelines issued for Underground and opencast mines for conduction of air born dust survey are required to be followed.
- Introduction personal dust sampling method in Opencast mines
- Dust suppression by water sprinkling and water spraying to be strictly ensured in Haul roads, man ways as well as working phases.
- Dust suppression by approved wetting agent.
- Dust suppression by Mist sprayer.(Cir 68/1970)
- Dry Drilling in mines to be completely stopped
- Education and training
- Personal hygiene
- Health surveillance

Examples of good practice for control of respirable dusts in quarries;-

- Wet drilling
- watering down
- dust suppression and capturing systems
- adequate re-entry arrangements
- As a last resort, correct use of respirators

Control of dust during drilling;-

- Dust control can be done by :
- By using sharp bits
- Wet drilling by using water.
- By using dust extractors
- By providing air tight enclosed cabins on drills rig and mobile equipment.
- By using personal protective equipments like respirators as the last resort

BLASTING DUST CONTROL & HAUL ROAD DUST CONTROL;-

- Employees to be evacuated to shelters located against the direction of wind flow.
- A minimum re-entry period shall be specified and applied.
- The charge and delays adjusted for minimum throw. In soft formation use In-holes delays.
- Spray adequate water on blasted muck.
- Water application to the road surface by tankers or from a pipe line.
- Use binding agents such as salts, surfactants, soil cements, bitumen and films
- No overloading of vehicles to prevent spillage and crushing on haul road.
- Inactive top and slopes of all dumps to be planted




Effects of Silicosis in Stone Quarrying and Mining

Shri Ganesh Murthy
M/s. Bannari Amman Sugars Limited

Effects of Silicosis in Stone Quarrying And Mining Industries

Silicosis is an respiratory disease is caused by inhaling crystalline silica dust, Persons effected by Silicosis are mainly from Stone Quarry and Granite Cutting and Polishing units ,In Stone quarry the workers and others are effected by inhaling the dust from the drilling, to avoid persons exposures to Drilling dust- wet drilling or Dust Collector system option in the drilling Machine to be adopted and wear Dust mask .

In the Granite Cutting and Polishing Unit dust are mainly from Cutting Slabs ,Tiles ,Nosing the edges and hand Polishing, which produces huge dust to avoid this work to be

done in the open area and wear Dust mask and Ear plug/muff ,

The dust produced from the above are in microns,which produces inflammation and scarring when it settles into the lungs. As time passes, this scarring causes the lungs to stiffen

The resulting silicosis is an ancient disease that causes scarring in the lungs, reduced lung capacity, heart problems and even death. ...

Stone/Granite Dust and Effects

Crystalline silica is a natural component of the earth's crust and is a basic component of sand, quartz, and granite rock. What are the health hazards of exposure to silica dust,Crystalline silica inhaled in excessive amounts can cause a serious and potentially fatal lung disease called Siilcosis

Silica content is generally lower in natural stone products. Calcium-based stones, including limestone and certain varieties of marble (e.g., calcite, dolomite, and onyx), contain little or no silica. In contrast, granite can contain up to 45- 50% silical, Persons may experience fever and sharp chest pain along with breathing difficulty. These symptoms can come on suddenly. In chronic silicosis, you may only have an abnormal chest X-ray in the beginning and then slowly develop a cough and breathing difficulty. silicosis usually takes anywhere from 20 to 45 years to develop, but even 5 to 10 years exposure time at higher concentrations can result in an accelerated version of the disease

There is no specific treatment for silicosis. Removing the source of silica exposure is important to prevent the disease from getting worse. Supportive treatment includes cough medicine, bronchodilators, and oxygen if needed. Antibiotics are prescribed for respiratory infections as needed, Sanding, grinding, or cutting concrete can also release large amounts of dust containing high levels of crystalline silica. Prolonged or repeated exposure can lead to a disabling and often fatal lung disease called silicosis. Silicosis is a lung disease caused by breathing in tiny bits of silica, a mineral that is part of sand, rock, and mineral ores such as quartz. ... Over time, exposure to silica particles causes scarring in the lungs, which can harm your ability to breathe. It is found in many materials common on construction sites, including soil, sand, concrete, masonry, rock, granite, and

landscaping materials. The dust created by cutting, grinding, drilling or otherwise disturbing these materials can contain crystalline silica particles.

These dust particles are very small.Igneous rocks (Granites). Igneous rocks are formed by the crystallisation of a magma. The difference between granites and basalts is in silica content and their rates of cooling. A basalt is about 53% SiO2, whereas granite is 73%..

Signs and symptoms include:

- Dyspnea (shortness of breath) exacerbated by exertion.
- Cough, often persistent and sometimes severe.
- Fatigue.
- Tachypnea (rapid breathing) which is often labored,
- Loss of appetite and weight loss.
- Chest pain.
- Fever.
- Gradual darkening of skin (blue skin)

Silicosis fatal

Silicosis can be fatal, This respiratory disease is caused by inhaling crystalline silica dust, which produces inflammation and scarring when it settles into the lungs. As time passes, this scarring causes the lungs to stiffen

The resulting silicosis is an ancient disease that causes scarring in the lungs, reduced lung capacity, heart problems and even death,But health experts estimate that thousands of construction workers are exposed each year and that at least 250 workers in all industries die annually from silicosis. Grout -- comprised of Portland cement, aggregates, limestone and often silica -- poses a health hazard through inhalation and skin contact. The dust can also cause eye irritation and even blindness. Exposure may result in short- or long-term physical problems, such as burns or respiratory disorders.

Permissible Exposure Limit for Silica

The PEL had been an average of 250 micrograms per cubic meter of air over an 8-hour shift. The 2016 OSHA (Occupational Safety And Health Administration) Silica Dust Permissible Exposure Limit reduces that average exposure limit to 50 micrograms per cubic meter.

Silicosis is a progressive, disabling, and often fatal lung disease. Cigarette smoking adds to the lung damage caused by silica. Lung cancer – Silica has been classified as a human lung carcinogen.(causing cancer in living tissue)

Causes of Dust in the lungs

Tiny hairs called silia, covering the walls of the air tubes, move the mucus upward and out into the throat, where it is either coughed up and spat out, or swallowed. The air reaches the tiny air sacs (alveoli) in the inner part of the lungs with any dust particles that avoided the defenses in the nose and airways.

Chronic silicosis: Usually occurs after 10 or more years of exposure to crystalline silica at low levels. This is the most common type of silicosis.

Accelerated silicosis: Results from exposure to higher levels of crystalline silica and occurs 5 to 10 years after exposure.The body does not utilisesilica in the form of silicon dioxide from the soil. ... Silica is one of the most important components of collagen, the chemical responsible for the look and feel of our skin, hair and nails. Collagen, and therefore silica, helps regenerate skin, hair and nails by repairing connective tissue.

Symptoms of silicosis

In acute silicosis, you may experience fever and sharp chest pain along with breathing difficulty. These symptoms can come on suddenly. In chronic silicosis, you may only have an abnormal chest X-ray in the beginning and then slowly develop a cough and breathing difficulty.

Additionally, breathing crystalline silica dust can cause silicosis, which in severe cases can be disabling, or even fatal. The respirablesilica dust enters the lungs and causes the formation of scar tissue, thus reducing the lungs' ability to take in oxygen. Occupational respiratory disease is any lung

Condition you get at work. ... coal workers' pneumoconiosis, also known as Black Lung Disease. asbestosis. silicosis.

It includes a broad group of diseases, including occupational asthma, chronic obstructive pulmonary disease (COPD), bronchiolitis obliterans, inhalation injury, interstitial lung diseases (such as pneumoconiosis, hypersensitivity pneumonitis, lung fibrosis), infections, lung cancer and mesotheliom.

OCCUPATIONAL RISKS BY SILICOSIS- Occupational with exposure to RCS (Respirable crystalline silica) include : Quarrying ,slate works ,Foundries ,Potteries ,Stonemasonry ,Construction when cutting or breaking stone ,Concrete or bricks and industries using silica flour to manufacture goods Different types of stone contain different amounts of silica.

Respirable crystalline silica particles are produced during many work tasks, including sandblasting, mining, rock drilling, quarrying, brick cutting, glass manufacturing, tunnelling, foundry work, stone working, ceramic manufacturing

To help prevent the development of silicosis, NIOSH recommends the following (National Institute for Occupational Safety and Health)

Sandstone, Gritstone, Quartzite	More than 70%
Concrete, Mortar	25% to 70%
Shale	40% to 60%
China stone	up to 50%
Slate	up to 40%
Brick	up to 30%
Granite	up to 30%
Ironstone	up to 15%
Basalt, Dolerite	up to 5%
Limestone, Chalk, Marble	up to 2% (but these can contain silica layers)

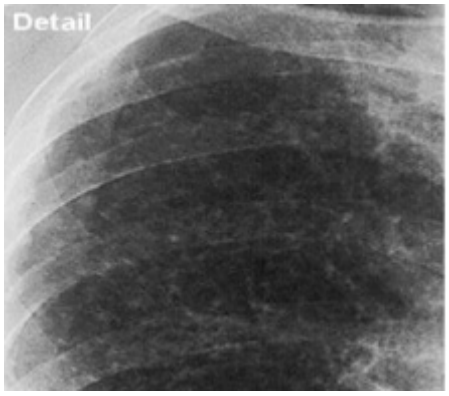
1. *Know the dangers of breathing in crystalline silica dust, and avoid working in or near dust whenever possible.*
2. *Remember: Even if you cannot see dust, you may still be at risk.*
3. *Use water spray systems and proper ventilation in confined spaces*

Silicosis – Take Control of it before It takes control of you

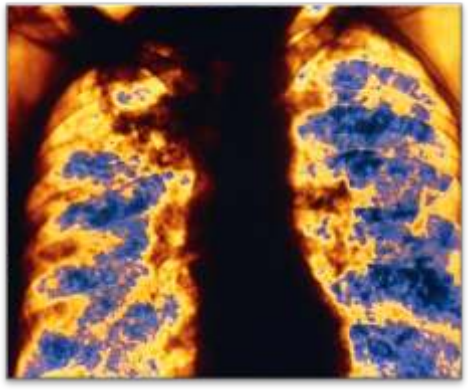
Dr. Krishnamurthy KV
Residential Doctor, M/s. Vedanta Limited

What is Silicosis?

Silicosis is a slow, progressive, occupational, irreversible pulmonary lung disease that usually occurs, after certain exposure with fine respirable crystalline silica particles (RCS).



X-ray of the chest area of a person suffering from silicosis.

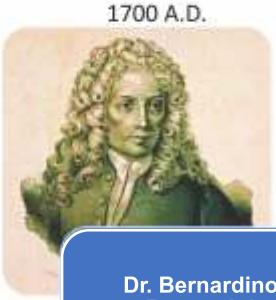


False-colour x-ray of the chest area of a person suffering from silicosis. [2]

Pneumonoultra microscopic silico volcanoconiosis"

History: World context

1700 A.D.



Dr. Bernardino Ramazzini (1633-1714)

Considered as the founder of occupational medicine, identified evidence of silicosis in stone cutters.

1916 A.D.

Dr. Alice Hamilton (1869-1970)

An American physician whose work resulted in significant safety and health reforms, first documented silica related illnesses among granite workers.

1930 A.D.

The Gauley Bridge tunnel project

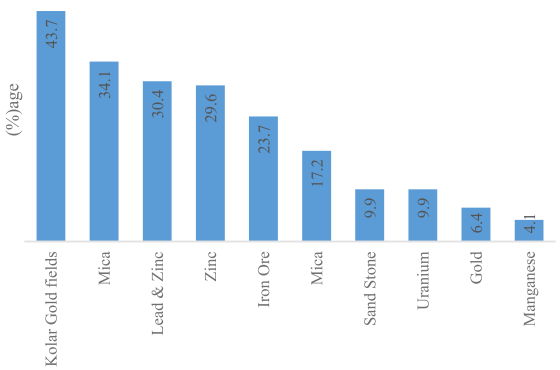
became the site of the worst industrial disasters in U.S. Hundreds of workers died from silicosis while building the tunnel and another 1,500 were reported to have the disease within two years.

Reference: World Health Organization

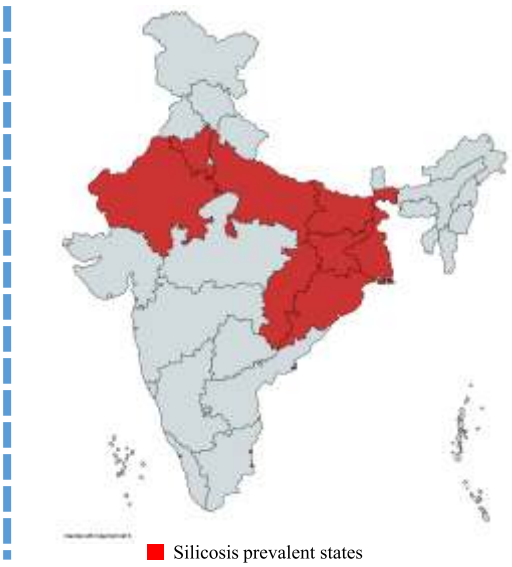
3

History: Indian context

It is caused by inhalation of dust containing silica or silica dioxide SiO_2 It was first reported in India from Kolar Gold Field mines, in Mysore in 1947. Silicosis was made a notifiable disease under Factories act 1948 and Mines act 1952.



Sector wise prevalence in India



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Pathphysiology of Silicosis

Inhalation of Silica Dust → Reach up to deep lung (Aleveoli) O_2 - CO_2 exchange get inhibits due to dust deposit. Dust can not be cleared by mucus

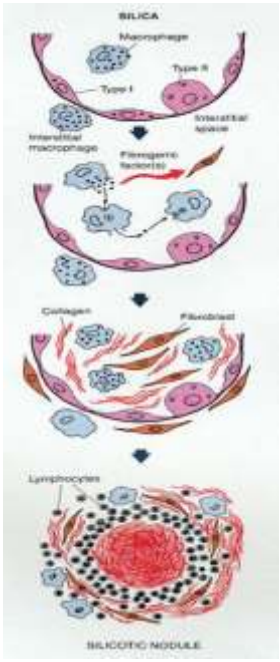
Tumor necrosis factor, interleukin-I, leukotriene-B4 & cytokines. → These stimulate fibroblasts to proliferate & produce collagen around silica particle

Fibrosis and formation of the nodular lesions

Silicosis affected lung slice

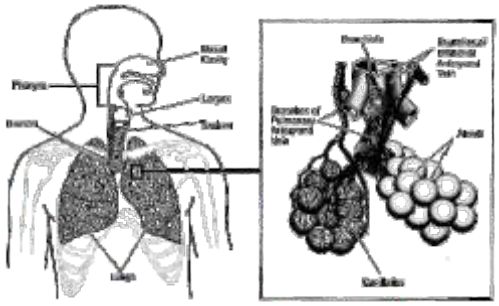
The incidence depends on:

1. Chemical composition of dust
2. Size of the particles
3. Duration of exposure
4. Individual susceptibility



Effects of Silicosis

Diseased and Healthy Lungs



Physical Weakness

Skin problems

Exposure wise Major Industries

Occupation	Exposure
Mining Milling	Silica contaminates the mined material Dry, finely ground silica (silica flour) for abrasives and filler
Quarrying and stone work	Slate, granite, and sandstone exposures
Foundry work	Silica as a mold: fettling and chipping to make a better molded product
Sandblasting	Ship building, oil rig maintenance, preparing steel for painting
Pottery making	Crushing flint and fettling are major sources of exposure
Glass making Boiler work	Sand used to polish and as an abrasive Cleaning boilers may result in exposure to refractory brick and clouds of quartz dust

Sources of Respirable Silica

Drilling

Demolition

Mining

Sand Blasting

Road work

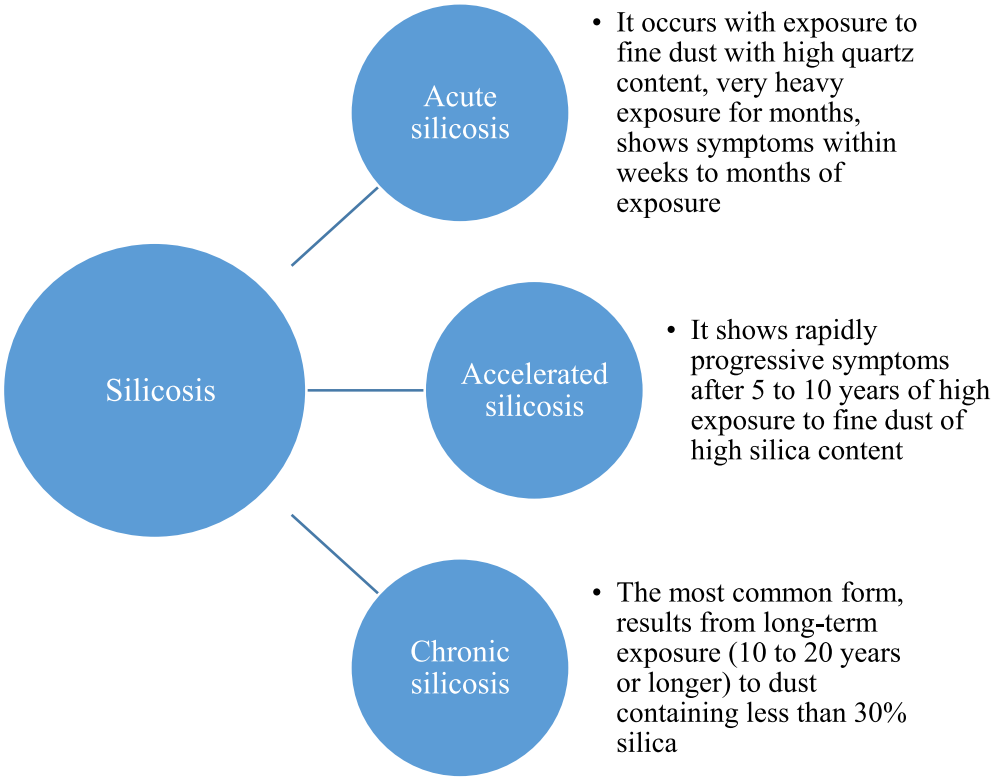
Cutting

Foundary

Grinding

Glass

Types of Silicosis



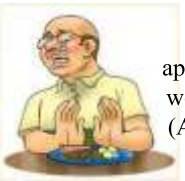
- It occurs with exposure to fine dust with high quartz content, very heavy exposure for months, shows symptoms within weeks to months of exposure
- It shows rapidly progressive symptoms after 5 to 10 years of high exposure to fine dust of high silica content
- The most common form, results from long-term exposure (10 to 20 years or longer) to dust containing less than 30% silica

Signs and Symptoms

Dyspnea (Shortness of breath) exacerbated by excertion

Cough, often persistent & sometime severe

Tachypnea (rapid breathing) which is often labored



Loss of appetite and weight loss (Anorexia)

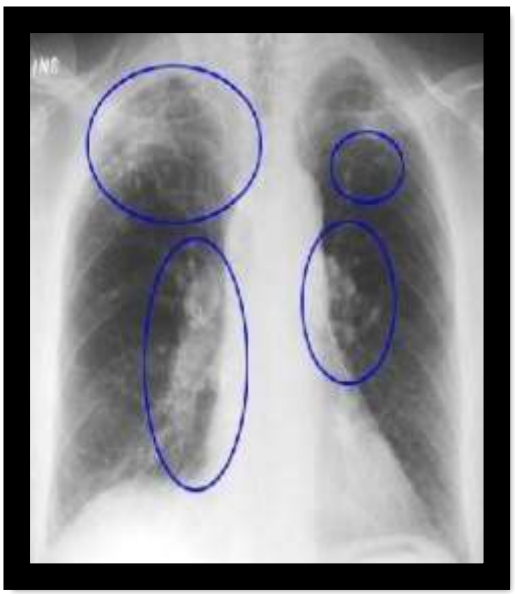
Gradual dark shallow rifts in nails leading to cracks as protein fibers are destroyed

Chest pain

Fever

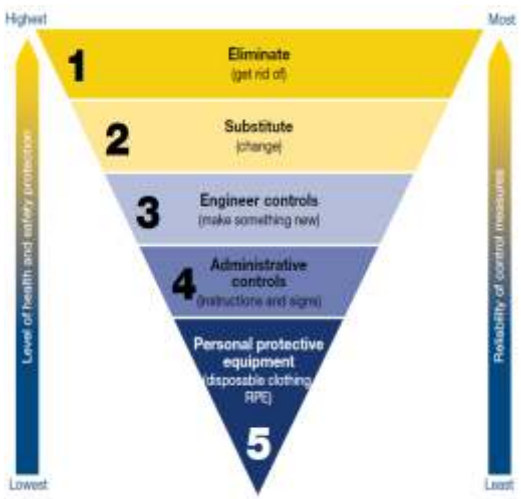
Fatigue

Detection of Silicosis



- Early detection is difficult- Absence of symptoms
- Radiography- X ray of chest (Shows fibrous tissues)
- Work History - Helps to diagnose Silicosis
- Lung function test using spirometer

Prevention & Control of Silicosis



At source

- Elimination of process
- Substitution/ modification of materials, processes & equipment
- Maintenance of equipment
- Wet methods

Transmission Path

- Isolation of the source and workers
- Local exhaust ventilation

At worker

- Work Practices
- Education and training
- Personal hygiene
- Personal protective equipment
- Health surveillance

Work environment

- Layout Change, storage & labeling
- Good housekeeping & Monitoring
- Warning sign for restricted area

You do have the choice of PPE's