

Dust Suppression by Modified Hand Tool, “Karauli Tanki” in Manual Stone Mining

1.0 Background

Daang Vikas Sanstha, (DVS) is a voluntary organisation working for welfare of stone mine workers in Karauli and other nearby districts. It has been specifically active in highlighting relief and rehabilitation of silicosis affected mine workers and creating awareness among workers for prevention of silicosis. In view of the large number of silicosis cases detected in Karauli and nearby districts, DVS has worked for simple and inexpensive modification of hand tools used in sand stone mines to reduce dust exposure to workers so that silicosis can be prevented to certain extent. In last few years, it has introduced use of modified Tanki which presumably reduced exposure of dust among workers. Therefore, DVS requested M/s Healthy Workplace Occupational Health and Hygiene Consultants to evaluate effectiveness of modification of hand tool “Tanki” on dust emission and provide independent opinion on its usefulness. It has also requested to make appropriate suggestions for improvement.

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2.0 Sand Stone Mining in Karauli District

2.1 Socio-economics of Sand Stone Mining

Karauli is one of the Southern-Eastern district of state of Rajasthan bordering Madhya Pradesh and is primarily a hilly area under Aravali hills. The geological formation of the district is pre Cambrian metamorphic rocks which is rich in limestone, sandstone, silica sand, etc. Karauli is famous for pink coloured construction stone used for carvings and also as stone slabs for roof and flooring. Livelihood of the rural population of this district is mainly dependent on agriculture, animal rearing and mining. The sandstone famously called Karauli stone is mined mostly in unorganized sector and 15 to 20 % of population is dependent on mining for livelihood.

There are approximately 1500-2000 sand stone mines with daily average employment of 5-20 workers. It is estimated that about 50,000 persons are directly and indirectly dependent on sand stone mining in Karauli district for their livelihood. The mining is seasonal and mines are operated by small entrepreneurs in unorganized sector. Sometime whole family is involved in working of the mine and wages are based on amount of stone extracted. It is not uncommon to have persons employed in mines from childhood.

2.2 Manual Method of Stone Mining

Karauli stone occurs in form of layers (patti) at the depth of few feet. The working in mines is wholly manual with little or no mechanisation. After removal of overburden, the stone slabs are manually cut in blocks of stone by making holes with chisels and hammers. The block of stone so separated is then split into layer of various thicknesses depending on natural stratification. The split stone slabs (patti) are sold as such or cut in small square slabs depending on nature of stone and commercial requirement. Karauli stone patti is basically used for making roof of houses and floors. With development of new technology, value addition in the form of polishing is also being carried out sometimes.



Fig 1 Manual Stone Mining in Karauli

The majority of mines employ less than 50 persons and do not use power or explosives, hence they are not covered by definition of mine under the Mines Act, 1952. The mine owners as well as mine workers are ignorant of health and safety requirements and due to general lack of education, awareness about safety appliances and occurrence of diseases due to work conditions is minimal.

3.0 Silicosis : An occupational Disease

Silicosis is an occupational disease caused by inhalation of airborne dust of Silicon Dioxide or Silica in the crystalline form also known as quartz. In mines, workers are

exposed to high concentration of silica dust almost at every stage of mining operation. However, drilling, blasting, loading – unloading of ore, crushing, etc. are some of the dustiest operations and workers in mines are at the risk of developing silicosis. Occurrence of silicosis is directly related to the degree of exposure to silica dust and higher the exposure more is the chance of developing silicosis. Silicosis is generally seen in sub-acute and chronic form after exposure to silica dust for many years. However, very heavy exposure to silica dust is known to cause acute silicosis.

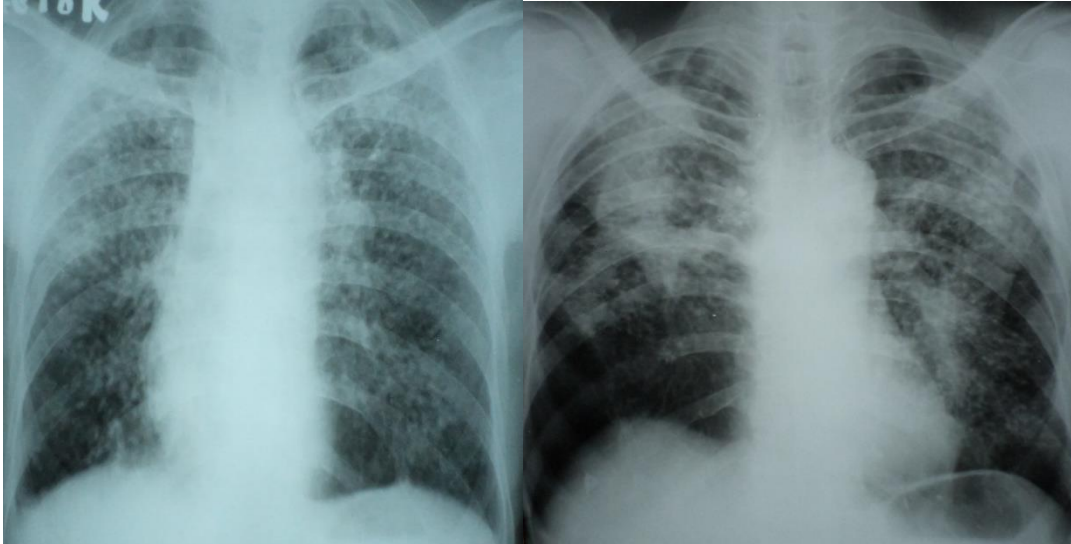


Fig 2 Cases of Simple Silicosis and Silicosis with Progressive Massive Fibrosis among Karauli Stone Mine Workers

Silicosis is a largely asymptomatic disease and there may not be any symptoms even though the radiographic appearances may suggest fairly advanced silicosis till the onset of Progressive Massive Fibrosis (PMF). Dyspnoea or breathlessness on exertion is the most frequent and directly related symptom, although it is rarely complained of in the absence of complicating diseases such as tuberculosis or bronchitis. The severity of dyspnoea increases with the progress of the disease. Slight unproductive cough may also be present at initial stages, however, the quantity of sputum increases later on. The symptoms usually resemble chronic bronchitis. Chest pain and haemoptysis are invariably due to associated pulmonary tuberculosis.

Chest radiography is the most important and universally used tool for diagnosis of silicosis. The radiographic diagnosis of silicosis can only be made after appearance of nodules particularly in upper and middle zones of lungs though High Resolution Computed Tomography (HRCT) can detect nodules at earlier stage. Silicotic opacities tend to increase even after cessation of exposure to silica dust. Pulmonary tuberculosis is the most frequent and an important complication of silicosis. The other common and invariably terminal complication of silicosis include repeated pneumothorax associated with combination of fibrosis and bullae. Development of progressive massive fibrosis at any stage invariably carries poor prognosis.

4.0 Silicosis in Karauli Stone Mines

4.1 Earlier Studies

Until detection of large number of cases of silicosis among stone mine workers in Karauli and nearby districts, it was generally believed that occurrence of silicosis is rare among small scale manual stone mine workers because of presumed low exposure to dust. However, this assumption proved to be completely misplaced with studies conducted in stone mine workers in Karauli and Jodhpur districts which showed high prevalence of silicosis among manual mine workers.

A study conducted by National Institute of Occupational Health, Ahmedabad detected 79 cases of silicosis in 2002 in Hari Rampura area. A number of studies and surveys conducted by National Institute of Miners' Health, Nagpur from 2011 to 2014 based of evaluation of medical records of present and former mine workers referred by DVS showed that 222 of 507 (43.8%) had evidence of silicosis. Further, of the 886 medical records of stone mine workers referred for consultation by Daang Vikas Sanstha to M/s Healthy Workplace, 556 (62.8%) had evidence of silicosis or silico-tuberculosis. Later studies conducted by Director General of Mines Safety has also shown that silicosis is rampant among sandstone mine workers in Karauli.

4.2 Current Situation

The studies on prevalence of silicosis in stone mine workers in Karauli conducted by National Institute of Miners' Health, Nagpur and its reports attracted the attention of the government of Rajasthan and formed the basis of relief and rehabilitation schemes of Mines and Labour Department and intervention by State Human Rights Commission. They also provided scientific basis for formulation of comprehensive **“Rajasthan Policy on Pneumoconiosis including Silicosis Detection, Prevention, Control and Rehabilitation”**.

Rajasthan state government has started a systematic programme for detection and certification of silicosis and has created an on-line silicosis portal for registration. It has also constituted Pneumoconiosis Boards in every district and Appellate Pneumoconiosis Boards in government medical colleges for certification of cases of silicosis and other pneumoconiosis. As per the data available on Rajasthan Silicosis Portal, more than 14,000 persons are registered for silicosis detection in Karauli district till October, 2020 and more than 1300 cases of silicosis have been detected in Karauli district. The data does not include cases of silicosis detected earlier.

5.0 Tools used in stone mining and dust hazards

As stated earlier, the working in stone mines is wholly manual with little or no mechanisation. After removal of overburden, the stone slabs are manually cut in blocks of stone by making holes with chisels and hammers. The block of stone so separated is then split into layer of various thicknesses depending on natural stratification. The split stone layers (patti) are sold as such or cut in small square slabs depending on nature of stone and requirement.



Fig 3 Workers mining stone slab and cut stone slabs in background

The tools used in extraction of stone blocks are simple and primitive. The chisels called “Tanki” in local language of various size and shape are used along with different size of hammers. The process is inherently dusty and lot of dust emanates during the process which is responsible for occurrence of silicosis among workers. Because of mushrooming of head of the chisel due to constant hammering there is also risk of injury to the fingers and hands from splintering of stone chips during the process.

6.0 Modification of Hand tools

Daang Vikas Sanstha has been associated with detection and prevention of silicosis in Karauli, Dholpur and other nearby districts since first time reporting of large number of cases of silicosis from workers of stone mines. It is engaged in creating awareness about silicosis among workers, employers, administrators, etc. since 2011. It has

worked toward rehabilitation of silicosis victims and improvement of work practices and tool to reduce dust exposure to workers during manual mining of stone. Daang Vikas Sanstha took the initiative by using low cost local technology to modify the tools in such a manner that dust exposure of workers is reduced substantially in order to prevent occurrence of silicosis without affecting productivity. Karauli being a water deficient area, it was also desirable that tool modification should be such that requires minimum amount of water.



Fig 4 Evaluating structure and composition of “Karauli Tanki”

The field officials of Daang Vikas Sanstha after studying the local requirement, available resources, suitability for local use, low water requirement, low cost and acceptability by the mine workers as well as the contractors carried out simple modification of the chisels used in creating holes in the stone block. The modified Chisel hence forth called “Karauli Tanki” involved insertion of a diaphragm of approximately 2.5” to 3” diameter mostly made of discarded rubber tube supplemented with 0.5” to 1” thick high density foam or rubber sponge.



Fig 5 Mine Worker preparing to use “Karauli Tanki”

7.0 Visit to the area and mine

Daang Vikas Sanstha engaged M/s Healthy Workplace Occupational Health and Hygiene Consultants which specializes in providing consultancy services in dust control and prevention of occupational diseases to study use of modified Tanki and its effectiveness in reducing dust exposure to workers and suggest improvement.



Fig 6 Discussion with Workers

An expert from Healthy Workplace along with officials of Daang Vikas Sanstha visited a stone mine in Soraya-Makanpur mining area about 10 kms from Karauli on 24th September, 2020 where stone mining was being carried out. The process of extraction of stone involved, making holes in the stone rock for extraction of slabs after removal of overburden. Depending on the dimension of rock, number of holes are made by hammering the chisel into the rock to the depth of 6 to 9" inches. Once the holes are made, the wooden plugs are inserted, water is poured and left overnight for splitting or hammered for separation of the block of stone. After separating of the block, it is spilt on lines of natural stratification for making patties.



Fig 7 Getting feedback from Workers on effectiveness of Karauli Tanki

8.0 Observation on use of Karauli Tanki

For use, the “Karauli Tanki” is soaked in water in a bucket or any container for water before being used for making holes. During hammering of the chisel for creating hole in stone, the wet soaked sponge captures most dust released and the rubber diaphragm prevents fly away chips of stone from injuring the worker. As the hole gets deeper, the diaphragm shifts upwards for adjustment to the depth of the hole. Once the hole is completed, the diaphragm is removed from Karauli Tanki and is dipped in water and squeezed which releases most of the dust captured by the sponge and the tanki is ready for use again.



Fig 8 Mine Workers using “Karauli Tanki”

During the visit and discussion with the workers, it was observed that modified “Karauli Tanki” prevented release of dust and exposure to the worker by capturing dust in the wet sponge. The diaphragm also prevented flying splinters of stones toward workers. Washing of tanki with small quantity of water in a buckets released substantial quantity of dust captured by the sponge. The diaphragm of 2.5 to 3 inches did not hamper visibility of worker while making holes or affect the productivity. Although, initially some of the workers did have difficulty in using Karauli Tanki, once they got used to it, productivity was not substantially affected and benefits far outweighed the reduction in productivity, if any. The workers also reported that there was drastic reduction in morning cough and production of brown coloured phlegm which was norm earlier. There was also reduction in hand and finger injuries during work while using Karauli Tanki.



Fig 8 Demonstration of use of Karauli Tanki by Mine Workers



Fig 9 Mine Worker showing Karauli Tanki after use



Fig 10 Close view of dust captured by Karauli Tanki



Fig 11 Dust released after use of Karauli Tanki

9.0 Suggestions and Recommendations

The initial observations suggests that use of Karauli Tanki in place of regular tanki reduces exposure of workers to stone dust during manual mining. It is simple to use and does not hamper productivity of the workers. It is also very cost effective, the modification costing 5 to 10 rupees only. It has been well accepted by the workers and the employers. Following suggestions are made for further improvement and to determine its quantitative effectiveness;

- a. The design of the “Karauli Tanki” may be standardized regarding the diameter of the diaphragm with respect to the length so that it does not hamper visibility of the worker while making holes and thus reducing productivity.
- b. The quality of material used for making diaphragm may be standardized and absorption capacity of sponge may be improved by use of better quality material instead of normal HDPE foam or rubber sponge.
- c. Although, the cost of Karauli Tanki is low, it can be further reduced by mass production of diaphragms.
- d. A comparative study may be conducted to determine reduction in dust exposure by use of Karauli Tanki and conventional tanki.
- e. A questionnaire survey may be conducted among workers for its effectiveness in reducing dust exposure and other beneficial effects.
- f. Use of simple cloth mask or mouth covering during work will further reduce dust exposure of workers and should be encouraged.
- g. The government authorities such as Inspector of Factories, Director General of Mines Safety and other authorities may be approached to propagate use of this simple but effective tool in prevention of dust exposure.
- h. If considered appropriate, Daang Vikas Sanstha may consider patenting Karauli Tanki” at some stage.

10.0 Summary and Conclusions

Silicosis remains the most important occupational disease of persons exposed to silica dust. Various studies conducted by national institutions have shown high prevalence of silicosis among stone mine workers in Karauli and other nearby districts. Manual stone cutting of sand stone is very commonly done in construction industry and mining. Karauli Tanki is simple, cost effective and easily acceptable innovative modification of hand tool used in manual stone mining and other similar working conditions. Although use of Karauli Tanki, may not fully protect workers and prevent occurrence of silicosis, it has potential to reduce dust exposure during manual stone mining substantially and thus reduce incidence of silicosis as prima facie the use of device substantially reduces dust exposure of workers but it has to be established by scientific data. If found effective, the simplicity of device, acceptability, cost effectiveness and use of local resources could help in reduction of dust exposure of workers and thus help in prevention of silicosis.