

# Low cost Dust Collector Model for Calcareous Shale Industry at Mandsaur of Madhya Pradesh, India

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**Abstract**-Calcareous word is an adjective which means percentage composition of calcium Carbonate, in some other words also as chalky or containing Lime. Shale is a superfine graded rock with minerals which is generally called Mud. In North India only Mandsaur have the slate-pencil rocks (Calcareous Shale's) thus the earning for living of people there is by making and selling this Calcareous Shale's also known as "PEM".



Fig. 01 – Slate Pencil or "PEM"

Silica is the main substance which is liberated in cutting these rocks with dust. This particulate matter of silica goes in body through nose and its prolonged exposure causes silicosis. Here in this research we try to overcome this problem by proposing the modification of their present technology which will be very useful and its by-product will also produce colored slate pencils. This will reduce the causes of silicosis to a great extent which is considered as the disease of poor as it is caused from poor working conditions of a poor slate pencil industry to poor people.



Fig. 02 – Slate Pencil Industry Cutting section

**Keywords**-Mandsaur, slate pencil industry, Calcareous Shale's, Silica, silicosis, particulate matter, Low cost Dust Collector.

## I. INTRODUCTION

Mandsaur also known as Mandsore is a city of Malwa region of Madhya Pradesh state of India. Mandsaur is rich in archeological heritage and it's mainly famous for Pashupatinath temple idol to one in Nepal. The slate pencil industry is main industry of the district. The name of the city came from two of village's viz. Marh and Dasaur which are been merged to make it town 'Marhdasaur' evolved to Mandsaur. The history is as long as Ramayana as this town is believed to be maternal residence of King Rawana as this was birth place of his wife 'Mandodari'. This is the main reason why Rawana is been worshiped in old city areas and no 'Rawan-dahan' was organized in Mandsaur on Vijayadashmi as they regard Rawana their Son-in-law.

Mandsaur district lies between latitudes 23° 45' 50" and 25° 2' 55" North and Longitude 74° 42' 30" and 75° 50' 20" East. The district extends about 142 Kms north to south and 124 Kms. east to west and comes under Ujjain Division [1].



Fig. 03 – Mandsaur City

Near this very old city soft rocks of silica are present, these if cut in small shapes like pencils known as "Pem" can write easily on black boards of small kids known as slate or "Patti".

Table 1 – Other Minerals found in Mp <sup>(2)</sup>–

<b>Annupur</b>	Bauxite
<b>Badwani</b>	Calcite
<b>Balaghat</b>	Bauxite, Copper, Dolomite, Limestone, Manganese, Quartz/Silica sand, Molybdenum
<b>Betul</b>	China clay, Copper, Coal, fireclay, Iron ore (H), Granite, Graphite, Lead-Zinc
<b>Chhatarpur</b>	China Clay, Diamond, Diaspora & pyrophyllite, Dolomite, Granite, rock phosphate
<b>Chhindwara</b>	China Clay, Dolomite, fireclay, Limestone, Manganese, Granite
<b>Damoh</b>	Dolomite, Limestone
<b>Datia</b>	Granite
<b>Dewas</b>	Dolomite, Quartz/Silica sand, barites
<b>Dhar</b>	Limestone, Ochre, Quartz/Silica sand, talc/steatite/soapstone, barites
<b>Guna</b>	Bauxite
<b>Gwalior</b>	China Clay, Iron ore (H), Ochre
<b>Harda</b>	Dolomite
<b>Hoshangabad</b>	China Clay, Dolomite, Limestone
<b>Jabalpur</b>	Bauxite, China Clay, Copper, Dolomite, fireclay, Iron ore (H), Limestone, Manganese, Ochre, Quartz/Silica sand, talc/steatite/soapstone, feldspar, Gold
<b>Jhabua</b>	Calcite, Dolomite, Limestone, Manganese, Vermiculite, Granite, rock phosphate
<b>Katni</b>	Bauxite, China Clay, Dolomite, fireclay, Iron ore (H), Limestone, Ochre, talc/steatite/soapstone
<b>Khandwa</b>	Quartz/Silica sand, talc/steatite/soapstone
<b>Khargaon</b>	Calcite, China Clay, Limestone, Quartz/Silica sand, talc/steatite/soapstone
<b>Mandla</b>	Bauxite, Dolomite, Ochre, feldspar, fuller's earth
<b>Mandsore</b>	Limestone, Calcareous shales (slate pencil use)
<b>Morena</b>	Limestone, Quartz/Silica sand
<b>Narsinghpur</b>	China Clay, Dolomite, fireclay, Limestone, talc/steatite/soapstone
<b>Panna</b>	Diamond, fireclay, Granite, potash
<b>Raisen</b>	China Clay
<b>Rewa</b>	Bauxite, Limestone, Ochre, Quartz/Silica sand
<b>Sagar</b>	Diaspore & pyrophyllite, Dolomite, fireclay, Limestone, talc/steatite/soapstone, rock phosphate

<b>Satna</b>	Bauxite, China Clay, Limestone, Ochre
<b>Sehore</b>	Limestone, Quartzite
<b>Seoni</b>	Dolomite, Granite
<b>Shahdol</b>	Bauxite, China Clay, Coal, fireclay, Limestone, Ochre, Quartz/Silica sand, feldspar, Gypsum
<b>Shivpuri</b>	Bauxite, Diaspore & pyrophyllite, barytes, Granite
<b>Sidhi</b>	Bauxite, China Clay, Coal, fireclay, Limestone, barytes, gold, Graphite, sillimanite
<b>Tikamgarh</b>	Diaspore & pyrophyllite, barytes
<b>Umaria</b>	Ochre
<b>Vidisha</b>	Bauxite

Our main emphasis here in this research will be on Mandasaur as it is main area of Calcareous Shale's Industries.

### What is Dust?

Dust can be defined as small, dry, solid particles projected into the air by natural forces, such as wind, volcanic eruption Etc. And man-made processes did in industries such as grinding, demolition, crushing, milling, drilling, shoveling, conveying, screening, bagging, Sweeping Etc.



Fig. 04 – Dust Liberation from Hopper

**Particle Aerodynamic Diameter of Dust** – Particle Aerodynamic Diameter of Dust is the diameter of a hypothetical sphere of density  $1 \text{ g/cm}^3$ , having the same terminal settling velocity in calm air as the particle in

question, regardless of its geometric size, shape and true density."

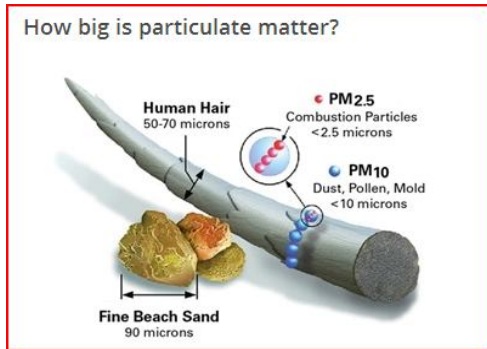


Fig. 05 – Size comparison of PM with human Hair

- The Air Masks – Even the best companies of world such as 3M, with proven test results from independent labs that they reduce inhaled exposure by at least 95%. This is exactly what N95 means, but they are costly <sup>{3}</sup>.
- Surgical masks are quite useless because they have air seeping in from all sides.
- However, all pollutants cannot be filtered out by using a normal mask, as Dr Penny Woods, Chief Executive of the British Lung Foundation, pointed out <sup>{9}</sup>.
- Most masks generally cannot filter out PM<sub>2.5</sub> in the air <sup>{10}</sup>.

Mandsaur Slate-Pencil Pocket area –  
 Slum {Pocket} Population – 37881  
 Public toilets in area – 48  
 No of Houses – 9000  
 People working in Slate-Pencil Factories ~ 8680



Fig. 06 – Multanpura Area with its dirty Lanes

**Current Malnutrition in Area** – The Children of area between ages 0-3 and 3-6 have huge malnutrition problems and the percentage rose to 54% of total 2366 children's.



Fig. 07 – Malnutrition in Multanpura Area

The study suggests that the prevalence of Silicosis and Silico-tuberculosis is still very high and both conditions constitute ~ **46.9%** among the slate pencil workers. Though the workers are using the indigenously developed control device it is not effective in controlling the dust. Instead it is capturing silica dust from workplace and liberates it in the ambient air thereby exposing the houses residing in the vicinity.

**II. MATERIAL AND METHODS**

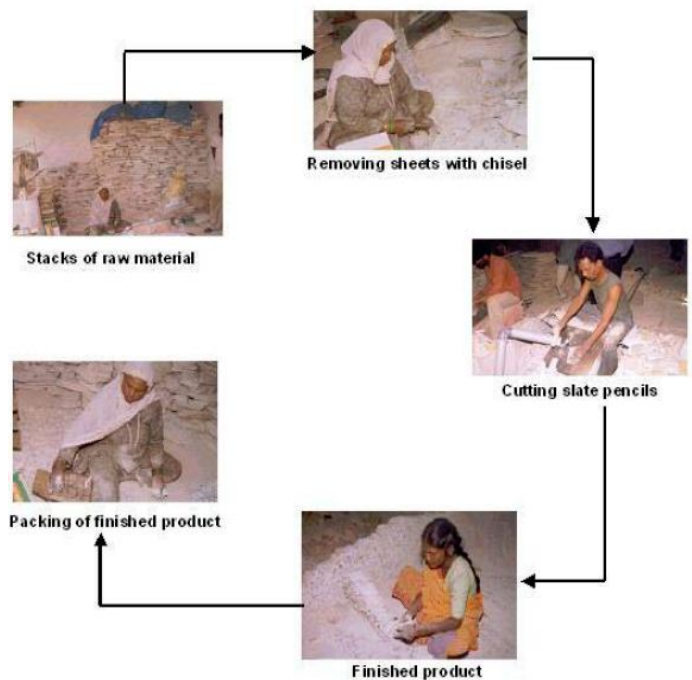


Fig. 08 – Process of Making Pem

As we can see in the above figure that the rock is obtained from open mining and then it's blasted to small pieces, these pieces are easy to transport to the cottage industry. The stalking is done in a room of approx 500 sq ft. the cutting machine is in between the stacks. The machine used for cutting is generally a two barrel machine which cut 2



pieces of slate pencil at a time. A vacuum section pump is placed near to the cutting blades which try to absorb the dust liberation from the pencil by dry cutting of stone. This pipe is joined with a pump and hopper, when this hopper gets filled the maids take the powder out of it by their hands and throw it away on unused land nearby i.e. open dumping. This powder with strong winds flow throw air to various areas nearby.

**III. OUR SURVEY**

We have seen about 89 working slate-pencil industries with 935 workers whom we asked various questions about working conditions and living conditions. The majority of people seemed to be affected by dust. As the Dust Concentrations (mg/m3) in the Work Environment of Slate Pencil Industry

Table – 2 Dust Concentration in 4 major Industries –

S. No.	Total Dust (mg/m3)	Respirable Dust (mg/m3)
1	1.93 ± 0.92	1.14 ± 0.05
2	1.73 ± 0.99	1.35 ± 0.37
3	1.39 ± 0.40	1.06 ± 0.45
4	1.27 ± 0.67	0.94 ± 0.29

More than 6,000 Slate-Pencil workers have died of Silicosis. It was found that average concentrations of Particulate Matter in the vicinity of slate pencil industry ranges between 41.07 µg/m3 – 57.22 µg/m3, Safe level of particulates not more than 10 µg/m3, The prevalence of Silicosis in community residing in the vicinity of these units is **12.6%** which is alarming.

**Adverse Effects of Slate-pencil Air Pollutants on Toddler’s Health –**

- a. Sudden Infant Death Syndrome
- b. Premature Birth,
- c. Low Birth Weight,
- d. Intrauterine Growth Retardation,
- e. Abnormal Birth Length,
- f. Abnormal Head Circumference
- g. Small Size for Gestational Age
- h. High risk of birth defects
- i. Childhood Asthma

- j. Deficits The Lung Growth
- k. Increased Risk of Vitamin D-deficiency
- l. Etc. etc.



Fig. 09 – Toddlers health effects

**IV. PROPOSALS**

Some of basic proposals needed to do with immediate effect are –

- a) Remove Houses From the Stack Vicinity
- b) Instruct workers to permanently remove themselves from other exposure zones
- c) Avoid respiratory irritants, and quit smoking.
- d) Silicosis often comes with respiratory infections, so antibiotics may also be prescribed.
- e) Avoid bringing dust home on clothes
- f) Use Good industrial respirators to be used
- g) A vacuum effectively minimizes dust exposures so floor mounted and roof mounted vacuums should be used

**What Can Employers Do to Prevent Silicosis?**

- a. Make a commitment to prevent silicosis at your worksites.
- b. Comply with Occupational Safety and Health Administration and Mine Safety and Health Administration regulations on respirable crystalline silica.
- c. Reduce exposure levels through the use of engineering controls.
- d. Provide appropriate respiratory protection
- e. Perform air monitoring of workstations as needed in factory,
- f. Take corrective actions when dust silica level increase.

- g. Monitoring provides a basis selecting and ensuring the effectiveness of engineering controls n selecting proper respiratory protection n seeing if work practices to reduce dust levels are effective and determining that a medical surveillance program is essential.

#### What Can Workers Do to Prevent Silicosis?

- Work with your employer to prevent silicosis at your worksite.
- Use engineering controls installed by your employer to reduce silica dust levels, and make sure they are properly maintained.
- Tell your employer when they aren't working properly.
- Minimize dust by removing with a water hose or vacuum with a high-efficiency particulate filter or by wet sweeping
- Wear, maintain, and correctly use approved particulate respirators as engineering controls alone are not adequate to reduce exposures below permissible levels.
- Beards, mustaches, long hairs generally interfere with the respirator seal to the face of worker making most respirators ineffective.
- If you must sandblast, use type CE positive pressure abrasive blasting respirators.

Our main aim is to remove  $PM_{10}$  and  $PM_{2.5}$  from going into nose, but this  $PM_{2.5}$  is the one as most of the masks cannot filter it out in the air. For this we propose a simple technique were the hopper present at the end of suction pipe should be filled with water. What it will do? Is that it will not let the dust and chalk partials from cutting section to liberate directly to the environment. These partials will get bubble out in water and will form sludge in water of slate pencil particulates. This sludge can be taken out and by it we can make a tricolor pencil. By this process we can reuse this waste material in our own business for profit. This process will also eliminate stacks present and there will be minimum pollution in the vicinity area. This will be helpful in reducing rate of silicosis in vicinity and also will be helpful in removal of malnutrition from the area. There are various sources of water present in and nearby the area as we can see in fig.

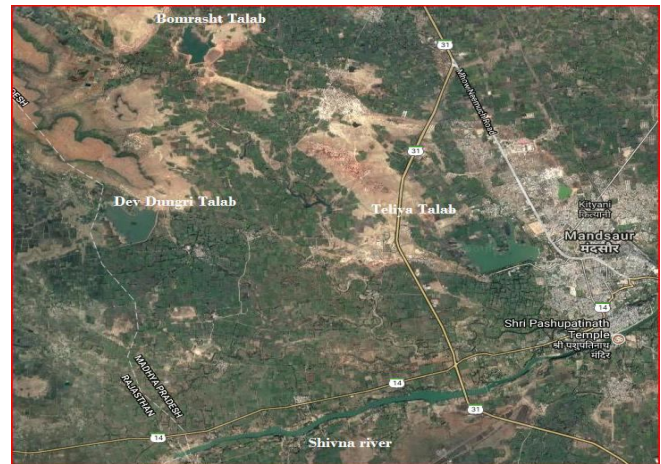


Fig. 10 – Various water sources near area

#### V. CONCLUSION

Silicosis is a big problem and many of the people have died due to it. The phrase comes in mind “Prevention is better than cure” this best fit with this disease as cure of this disease is not possible. Here in this research we proposed a simple, economical, sociological and commercially feasible technique of using water in the hopper which will give them more profit with lesser pollution. The three colored slate pencil is generally made by wet process so in my opinion the objective of research is complete.

#### REFERENCES

- Chief Adviser of Factories, Ministry of Labor, Government of India, Investigations on the Incidence of Occupational Diseases in the Manufacture of Dichromate and in the Mining and Concentrating of Chromites (Government of India), 1953.
- Chief Adviser of Factories, Ministry of Labour, Government of India, An Industrial Hygiene Study in a Ferro-manganese Plant (Government of India), 1962.
- <http://googlemaps.in>
- <http://metro.co.uk/2017/02/01/how-do-pollution-masks-work-and-is-it-worth-getting-one-6406889/>
- <http://www.3m.com>
- <http://www.samataindia.org.in/mici/2012-06-22-10-53-53/minerals/states/56-madhya-pradesh/56-madhyapradesh>
- [http://www.who.int/occupational\\_health/publications/en/ohairbornedust3.pdf](http://www.who.int/occupational_health/publications/en/ohairbornedust3.pdf)
- <https://en.wikipedia.org/wiki/Mandsaur>
- USEPA. 1995. U.S. Environmental Protection Agency. The Use of the Benchmark Dose Method in Health Risk Assessment. EPA/630/R-94/007. Washington, DC: U.S. EPA. 46 FINAL February 2005

- [10] USEPA. 1996. U.S. Environmental Protection Agency. Ambient Levels and Non cancer Health Effects of Inhaled Crystalline and Amorphous Silica: Health Issue Assessment. EPA/600/R-95/115. Office of Research and Development. Washington, DC: U.S. EPA.