Dust Emission Due to Stone Crushers in Pune

G. N. Supe[1], P. A. Manatkar[2], S.C. Tandale[3]
[1]*Assistant Professor, Pimpri Chinchwad College of Engineering and Research Ravet, Pune, Maharashtra, India*
[2,3]*Assistant Professor, Trinity Academy of Engineering, Pune, Maharashtra, India*

***Abstract*— Dust is smallest matter of crushed aggregate which present in the open atmosphere. Due to the physical and chemical properties of dust particles, they cause adverse impacts upon the environment, atmosphere, human being and overall surrounding Earth's system. Dust is being emitted from different crushing industries, which becomes a serious problem for living and non living things. Particles flow in open atmosphere for longer distance due to wind which blows from crusher's area. Weather condition, wind speed, wind directions and characteristic of dust particles are responsible factors for distribution of dust particles. The precautions taken during the processing of aggregates can help to reduce the emission of dust particles in the atmosphere.**

The study represents the dust emitting sources, dust pollution and its effects on different plants, sources of surface water and ground water in Katraj of South Pune, Maharashtra. The region is in developing phase which produces large amount of aggregates and hence generate huge quantity of dust matter.

***Index Terms*— Dust, Dust Pollution, Crushers, Aggregates, Ground water sources, properties of dust, effects of dust pollution.**

I. INTRODUCTION

Pune ranked second largest city in the state of Maharashtra and 8th largest metropolises in India due its economical and industrial growth [1].

By Population, Pune is 101st largest city in the world. Pune is known as the educational and cultural capital of Maharashtra. In industry point of view, Pune is one of the fastest developing cities in the Asia region [2]. As per the report given by the 'Mercer 2015 Quality of Living rankings', Pune stood at 145 for local living conditions among 440 cities around the world and 2nd in India [3]. It is also in 9th cities around the world which are known for Hosts IT and automotive companies.

Pune is a social, cultural and educational capital of the state of Maharashtra and it is at the altitude of roughly 560 m above mean sea level, in the Sahyadri Range of Hills close to west bank of nation. Pune Municipal Corporation has command over a territory of about 243 km^2 what's more, generally some zone is sloping area, so because of increment in populace, decimation of this nature has been seen in some last a very long time for satisfying prerequisite of open which at last causing contamination and consequently influencing a situation. Katraj is area of Pune in the Indian Territory of Maharashtra, and inside the locale of Pune Municipal Corporation. It is well known for its Peshwa-time lake that provided water to the city during their period [4]. Katraj lies at the one end of the Katraj Ghat or mountain pass on the National Highway 4 interfacing Pune with places south of the city, for example, Kolhapur and Bangalore. In ongoing decades zone encompassing the lake and the town of Katraj turned out to be part of Pune. The previous provincial territory is presently encompassed by private edifices. The lakeside has the Rajiv Gandhi Zoological Park which is famous for tourism.

The aggregate producing crushers are significant for local economy however have adverse impact on air quality because of emanation of residue particles in encompassing region, which results in respiratory sicknesses, poor visibility in close by region and decrease in development of vegetation.

A stone crusher is a machine intended to decrease huge rocks into smaller shakes, rock, or rock dust. Crushers might be utilized to diminish the size, or change the structure, of waste materials so they can be all the more effortlessly discarded or reused, or to lessen the size of a strong blend of crude materials, with the goal that bits of various piece can be separated. In this process, tiny dust particles escape into the open atmosphere. All stone crushers can be

delegated falling into two primary types. Compressive stone crushers that press the material until it breaks and impact stone crushers utilizing the standard of snappy effects on pound the material. Jaw crushers, gyratory stone crushers, and cone work as per the pressure standard. Tiny particles in the air of a closed atmosphere can be breathed in or caught in salivation or any other body fluid. Dust matter is very variable in concentration, origin, size distribution, concentration, and nature. Naturally formed particulate arises from erosion, storm, and emitted from forest fires and volcanic activity. Primary particles are released into the atmosphere in solid or liquid form, whereas secondary particles are produced in the atmosphere by gas-to-particle alteration of oxidation products of released precursors. The diameter of dust particles decides behavior, dynamic properties, and fate during transport. Large diameter particles are of crystal origin, and from natural sources. The very small particles relates to the highest level of concentration of toxins and trace elements from anthropogenic sources and radioactivity from natural sources. Chemical and physical properties of dust indicate the sources emitting the particles. It helps to recognize the parameters that should be specifically targeted for various types of emission sources operating in the environment under investigation [5].

Dust is a known as primary aerosol which emitted directly from the crushing units. It has a harmful effect on community and atmosphere including plants and animals, such as, it changes the soil pH and its productivity, forms haze which reduces the visibility in the surrounding areas, it destruct the habitat, and also destroy the natural resources such as vegetations and wild lives, promoting many diseases etc [6].

Dust particle characteristics mainly depend on both dust formation and post processes done on the rock pieces. Fine and coarse dust particles may have different chemical composition and origins, are carried and emitted in different mechanisms, and they require various tracking techniques. There has been a great deal of work to identify emission sources and particulate emissions based on structure, elemental and isotopic ratio, and other characteristics called source markers.

II LITERATURE REVIEW

Dulal Chandra Saha and Pratap Kumar Padhy worked on formation and distribution of dust matter in the state of West Bangal and published their work in paper, Effects of stone crushing industry on Shorearobusta and Madhuca Indica foliage in Lalpahari forest in Centre for Environmental Studies, Institute of Science, Visva–Bharati University, Santiniketan–731235, and India. In their research work they have concluded that forest decline is because of the industrial development which resulting air pollution. Intrusion of the forest due to crushing activities of the naturally occurring stones since early 1960s is found in the district of Birbhum, West Bengal, India. The purpose of work was to find the effect of stone crushing industry on different parameters of Madhuca indica and Shorearobusta which are two broad–leaved tree species of the area concerned. The dustfall was measure in the area [6].

The work of R.T. Egami and his colleagues in particle fallout container measurement of dust from the atmosphere had determined the rate of dustfall with particle fallout measurement apparatus [7]. As per their suggestions the cone of the apparatus can be made by using glass, plastic or stainless steel. Along with the open cone they used sieve no 18, non-porous crucibles and filter funnel to determine the dustfall.

As published in the report titled comprehensive report of dust fall measurement for CGPL (Coastal Gujarat Power Limited), CEG test house and research centre Pvt. Ltd. mounted dustfall stations at 1.3 m by using tripods to neglect the dustfall due to by wind eddies. In the study, the soluble and insoluble dust fall was also determined. It was found that the rate of soluble dustfall was found to be higher in summer whereas it was lesser in post monsoon and winter season [8].In the paper, Methods of Measuring Sulfur Dioxide, Dustfall and Suspended Matter in City Air, F. L. Petrilli had used a semi automatic apparatus for measuring dustfall in Genoa, Italy. By using that apparatus direct reading of sulfur dioxide concentration could be possible [9]. The concentration of sulfur dioxide was found to be 2.95 mg per 100 cm^2 per day.

Dustfall quantity was measured from two dust storms in southwestern Iceland in summer season of 2015. Measurements of dustfall from both storms started after the dust plume which was visible at Reykjavík forming the horizontal profiles [10]. The first storm was found at Landeyjasandur which is at 100 Kms

from Reykjavik. The other dust storm formed at Hagavatn which at 85 km from Reykjavik. The monitoring of these two storms were done by using camera network from the Icelandic Road and Coastal Administration. In the article written by Shanram Nazari, e.t al. it was stated that dustfall was responsible for different diseases and it was found that the increase in the concentration of dustfall by 100 μg/m^3 the incidence of chronic pulmonary increased by 27%. and pneumonia by 19% [11] . The large number of premature deaths due to dust pollution of around 800,000 annually was recorded by WHO [12]. The annual cost reported for healthcare facility against the health problem caused due to dust pollution is about £30 billion in Austria, France and Switzerland. The huge concentration of dust particles in dust storm was recorded more than 6,000 μg/m^3 [12].

III METHODOLOGY

The study of dust emission, its concentration and distribution was completed in South area of Pune. This area is becoming more and more advanced due to speedy construction activities. There are lots of construction sites in this area whose are emitting huge dust particles in the open atmosphere. The main sources of dust emission are stone crushers and stone crushing mines. Katraj is selected as study area, which is the Southern part of Pune city. It is surrounded by many hilly ranges, open sources of ground water like lakes and streams. On geographical scale this area is situated at 18°27'13"N 73°51'42"E. The study stations were selected on the basis of dust emission and the sources of surface and water in the area. The quantity of dustfall in the area was determined for the period of few months. For this experimentation four study stations were selected which are as below:

1. The traffic Junction, Khadi Machines Chouk, ("Station 1")
2. North Yewalewadi, around 21 crusher units within 3 Km^2 area ("Station 2").
3. South Yewalewadi that Wadachiwadi ("Station 3").
4. KJEI campus that is Trinity College ("Station 4").

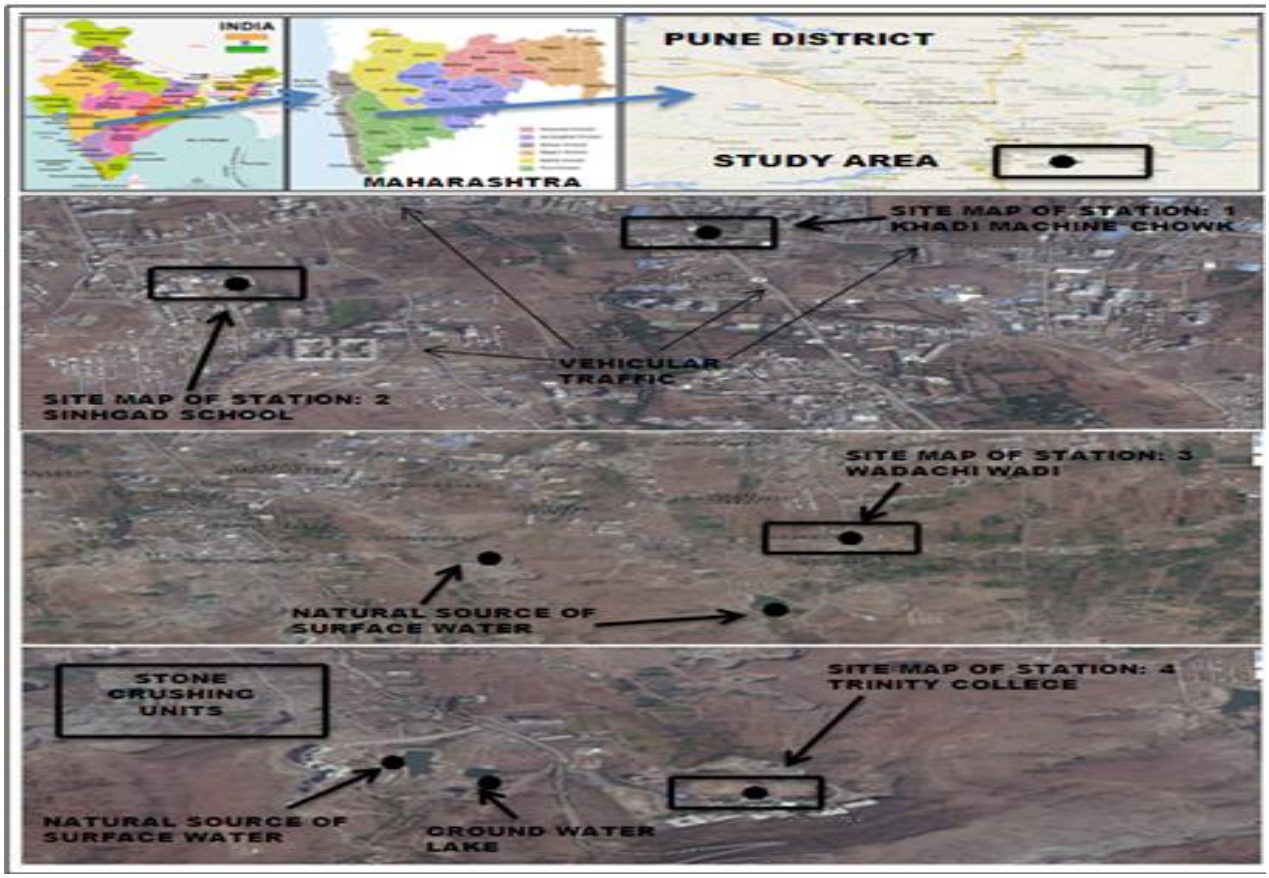

Fig. 1 Study Areas in Katraj, Pune, India

"Station 1" that is Khadi Machine Chouk situated near a crushing unit. The dustfall in the area transmitted due to force of air and heavy traffic which connects Yewalewadi to Kondwa as well as Katraj to Wadachi Wadi. Whereas "Station 2" that is North Yewalewadi is surrounded by around 21 crusher units. The said area is open and affected by huge free dust fall. "Station 3", Wadachiwadi basically situated in South part of Yewalewadi. This area is a source of ground water in which huge dust falls in the large wells. The water is getting contaminated due to the dustfall. The surface water source is receiving large quantity of dust fall. Due to seepage taking place at the bottom of lake, the dust is being percolated in the ground which may results in the blockage of voids. The site map of station 4 is shown in the Fig. 1. It is the educational hub situated at the bottom of Bopdev ghat. This area is surrounded by hilly ground formations which results the large dust accumulation in over the area. Trinity College campus is exposed to free dust which is emitting from crushing units running nearby the area as shown in Fig.1. Many natural sources of surface and ground water are under the influence of crushing units.

Determination of dustfall: In the study area, the dust emitting sources were different aggregate processing industries. The several units of rock crushers were found to be working for around 10-12 hours every day. The huge quantity was being processed and transported from the area. The processing on crushed rock pieces, its method and the control measures determines the quantity of dust emission. Many crushing units are located at top of the hilly areas which are responsible for spreading the dust at longer distance in the nearby area. The dustfall was determined by the Glass Jar method in which glass jar were placed at certain stations for a period of 24 hours. The glass jar of height 20 cm and diameter 10 cm were used in the experimentation. The glass jars were placed in the open area at different station at particular height from the ground as shown in Fig.3. Before placing the glass jars, the jars were dried and clean by a cloth. The initial weight of the glass jars were recorded and placed at the site locations keeping the top end open to the atmosphere as shown in the fig. 2. jars, the jars were dried and clean by a cloth. The initial weight of the glass jars were recorded and placed at the site locations keeping the top end open to the atmosphere as shown in the fig. 2. The dust falling over the area was being collected in the jars. After the period few hours the jars were removed and the final weight was recorded without disturbing the dust collected in the jars. The dust collected for certain period of time is converted into one day.

Fig. 2 Glass Jars Placed at study station 1

By calculating the top open area of glass jar, the quantity of dustfall was determined in terms of g / m^2 day. The dustfall was calculated by using following formula,

$$PM\ Dust\ fall\ \left(\frac{g}{\mathrm{m}^2\ day}\right) = \frac{PM\ mass\ (g)\ x\ 1}{\pi r^2\ \mathrm{x\ n}}$$

In this formula, ($\pi r^{2)}$ represents the cross sectional area of the glass jar opening in m^2, 1 represents one day duration of dustfall and n represents the actual period in hours for which glass jar was placed at the study stations [6]. Two glass jars were placed at every study station to determine the accurate dustfall. The glass jars were labeled as A1, A2, B1, B2 and so on

IV RESULTS AND DISCUSSION

The dusfall was determined at different four study stations. Glass Jar Id, Initial weight of glass jar, Time of Placing and removal of glass jar and final weight glass jar was recorded every time. By the recorded data, the weight dustfall (g) in the glass jar was computed. The opening area of glass jar was calculated by using the formula of area of a circle= $\pi r2$, where r is the radius of cylindrical glass jar. The

dustfall was recorded at all stations and the tables were prepared as shown in Table no. 1.

Table No.1: Dustfall (g/m2 day) in study area

Station No.	Glass Jar Id	Initial Weight Of Glass Jar (g)	Placing Time Of Glass Jar	End Time	Total Duration (Hrs)	Final Weight Of Jar (g)	Weight Of Dust Fall (g)	Dust fall (g/m^2 Day)	Average Dust fall (g/m^2 Day)
S1	A1	336.02	11:30 AM	11:30 AM	24	337.12	1.1	35.03	37.1
	A2	328.01	11:30 AM	11:30 AM	24	329.24	1.23	39.17	
S2	B1	330	12:15 PM	12:15 PM	24	331.3	1.3	41.40	41.71
	B2	335	12:15 PM	12:15 PM	24	336.32	1.32	42.03	
S3	C1	331.31	12:45 PM	12:45 PM	24	332.92	1.61	51.27	51.59
	C2	332.32	12:45 PM	12:45 PM	24	333.95	1.63	51.91	
S4	D1	330.01	10:15 AM	10:15 AM	24	330.8	0.79	25.15	23.56
	D2	330.01	10:30 AM	10:30 AM	24	330.7	0.69	21.97	

The station 3, Wadachiwadi, was found to be affected by heavy dustfall with an average dustfall of 51.59 (g/m^2 Day). The station 4 was exposed to lesser dustfall of an average 23.56 (g/m^2 Day). Station 1 and station 2 are recorded with moderate dustfall of an average 37.1 and 41.71 (g/m^2 Day) within 24 hours. The dustfalls were recorded for several weeks at all the stations in the post winter and summer seasons. The weeks were represented as W1, W2, W3 … W7. The crushers were working in all the weeks. The aggregate processing and transporting was carried to fulfill the need of construction sites. The average dustfalls were measured in the dry weather condition. The dustfall results seemed to increase at all stations from W1 to W7 due to the rise in temperature of local atmosphere as the season shifted from winter to summer.

The average dustfalls for weeks for all the study stations were recorded. The station 3, Wadachiwadi, which is covered by exposed soils, the roads in the area are also covered by dry dusty soil. The lots of crushers units were found to be always opened in the area resulting in the huge dustfall in nearby area. The average dustfall per week recorded at station 3 was found to be highest as shown in Table No. 2. as an average more than *300 (g/m^2 week)*

Table No.2: Dustfall (g/m2 week) in study area

Station No.	GJ ID	Total Dustfall (g / m^2 Week)							Average Dustfall (g/m^2 WEEK)
		W1	W2	W3	W4	W5	W6	W7	
S1	A1	218.20	222.10	228.32	185.20	215.25	224.30	229.36	217.53
	A2	215.20	218.60	221.25	180.25	216.20	221.10	226.20	214.11
S2	B1	230.30	232.23	246.11	218.28	241.24	266.50	289.81	246.35
	B2	235.20	240.36	247.23	210.23	237.60	280.43	294.27	249.33
S3	C1	340.22	342.01	345.20	240.15	332.23	342.90	358.92	**328.80**
	C2	350.30	354.25	362.10	262.23	348.50	362.20	386.2	**346.54**
S4	D1	136.25	139.40	147.50	120.01	138.50	158.60	176.11	145.20
	D2	121.23	124.36	126.45	105.20	118.25	138.53	153.82	126.83

The highest dustfalls recorded at station 3 were 328.80 and 346.54 (g/m2 week). The station 4 was found to be affected lowest dust fall of 145.20 and 126.83(g / m2 Week).

The crushers were responsible for the huge dust emission in the study area. The sources of surface water like streams and lakes received large dustfall.

V. CONCLUSION

The crushing industry is the main cause of dust production and there is a lot of dust emission in the selected study area due to the stone crushers. Climate change is also the cause of the spread of dust, the warming of the atmosphere is conducive to the spread the dust. Along with changing environments, methods of controlling dust should also be changed so that dust can be restricted. Restricting the spread of dust will definitely help to improve the health of the community.

REFERENCES

[1] www.pune.gov.in
[2] www.punesmartcity.in
[3] www.uk.mercer.com
[4] Joshi, S., 2007, "Sustainable Management Plans for Urban Lakes in India". In Proceedings of Taal2007: The 12th World Lake Conference, (Vol. 1202, p. 1207).
[5] A. Buekens, Department of Chemical Engineering – CHIS 2, Vrije Universiteit Brussel, Belgium, "Dust - Particle Formation and Characteristics", Pollution Control Technologies – Vol. I
[6] Saha and Padhy "Effects of stone crushing industry on Shorea robusta and Madhuca indica foliage in Lalpahari forest" – Atmospheric Pollution Research 2 (2011) 463-476
[7] R.T. Egami, John G. Watson, C. F. Rogers and Michael Ruby, "Particle fallout container measurement of dustfall from the atmosphere", Methods of Air Sampling and Analysis, Publisher: Lewis Publishers, Chelsea, MI, Editors: J.P. Lodge, pp.440-445
[8] Report by CEG test house and research centre Pvt. Ltd, on "comprehensive report of dust fall measurement for CGPL (Coastal Gujarat Power Limited)", November 2014- June 2015
[9] F. L. PETRILL, "Methods of Measuring Sulfur Dioxide, Dustfall and Suspended Matter in City Air, and their Use in the Study of Air Pollution in Italy", 1962, 26, 495-512
[10] Agnes Osp Magnusdottir, Haraldur Olafsson and Olafur Arnalds, "The Spatial Variation of Dust Particulate Matter Concentrations during Two Icelandic Dust Storms in 2015", Atmosphere 2016, 7, 77
[11] Ezzati M, Lopez AD, Rodgers A, Murray CJL, Comparative quantification of health risks. Global and regional burden of disease attributable to selected major risk factors Geneva: World Health Organization 2004. p.89.
[12] Anderson JO, Thundiyil JG, Stolbach A., "Clearing the air: a review of the effects of particulate matter air pollution on human health", Springer, 2012; 8(2): 166-75.