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Heavy Dust Pollution around South Katraj Region

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Abstract: ***Dust is basic element of the environmental pollution formed due to daily activities. The emission of dust particles became an important issue to be resolve. All the available sizes of dust particle affect human life and surrounding environment. The health effects of such dust pollution are being noticed since last few decades. It can be minor or major health effects which designate the loss of human life. The huge emission of dust from stone crushing units and construction industries challenges the environment agencies to avoid the loss of ecosystem. The loss of air quality due to dust pollution asks for the preventive measures. The stone crushing industries running in hilly areas of South Katraj region generates huge dust; which is being deposited in open atmosphere. The growth construction industries in nearby region demand large quantity of aggregates. The manufacturing process of aggregates at South Katraj region emits dust through surface drilling, blasting, crushing, milling, and screening. The emitted dust flows with speedy wind and start falling in surrounding areas. Wind speed and flow direction helps to drop the dust particles in each part of surrounded area. The dustfall resulting from stone crushing industries have affected the quality of air, water and vegetations. The dustfall quantities of few stations were determined by experimentation. The observed values of dustfall in South Katraj region were found to be unpredictable. The effective preventive measures can save the environment of South Katraj region.***

Keywords: South Katraj, Dustfall, Stone Crushing Industries, Dust pollution control etc.

1. Introduction

The rapid industrialization and growth of Pune city is being noticed since last few decades. The rapid industrialization and migration of people helped to develop city at all stages. The construction of industrial building, commercial complexes and market places have deviated the economy of city. The growth rate increased the demand of building materials required for construction industries. The need of increased building materials such as aggregates is being fulfilled with the help of natural resources of region. The city area is gifted with verdant hills and natural sources of water along with the beautiful greenery.

The city is covered by hilly regions which is being a source of aggregates. The mining operations needed for the manufacturing of aggregates produce large amount of dust. The hazardous level of dust emission is dangerous for local environment. The federal regulations are needed to be set to control the dust emission and its distribution.

2. Literature Review

The dust emission factor published by US EPA controls the different types of emissions to be released into the atmosphere. Emission factor defines the quality of a pollutants and its rate of generation. The given emission factor for construction related operation was 1.2 ton per acre per month [1]. The research on dust pollution and the content of heavy metals was conducted by Thabet A. Mohamed et al. in Egypt. They had determined the content of zinc, lead, mercury, cadmium and other hazardous metals from the dustfall [2]. Stone crushing industries emits huge amount of dust of particle size diameters between 1 µm to 75 µm. The lighter particles transported over long distance and heavy settle down in nearby area [3].

Jessica Agarwal et al. summarized the mass distribution of dust particles released in atmosphere [4]. The mass distribution of particles were measured analyzed by astronomical images by using direct modeling. The further approach was to determine the sizes of dust grains.

The limestone dust fall was measured by Brandt & Rhoades in 1972 in Virginia, USA. The effect of dust fall on structure of natural woodland was a focused topic of their research. The different sites were selected which had proved the effect of dust fall on vegetations [5]. The study of Manning (1971) described the effect of dust on trees. The leaf of plant were showing darker green color when it exposed to dust emission area [6].

Terramin Australia Ltd had collected and analyzed the dustfall data from different gauge location. The analysis was carried out to determine the level of dust emission of zinc mine [7]. Dulal Chandra Saha and Pratap Kumar Padhy worked on determination of dustfall emitted from stone crushing industry by using glass jar method. They also focused on effect of stone crushers on vegetation. Two species of plants were selected for the study purpose. The dustfall was determined on Shorearobusta and Madhuca Indica foliage in Lalpahari forest in Centre for Environmental Studies, Institute of Science, Visva–Bharati University, Santiniketan–731235. The rate of photosynthesis was found to be decrease due to loss pigmentation [8]. Das et al. (2002) determined the concentration of dust in two different seasons. The dust emission rate measured for post–monsoon was higher than pre–monsoon. The concentrations of dustfall measured in a stone crushing area were 3204 and 4354 µm/ m^3 [8].

The level of dust emission was established by National Ambient Air Quality Standards (NAAQS) provided by the Central Pollution Control Board (CPCB, 1995). The level defined for SPM is below 500 µg/ m^3 for industrial areas and according to the EPR, 1986 the particulate matter emission value should not be greater than 600 µg / m^3 [9].

3. Methodology

3.1 Materials and Methods

The dust pollution in selected study area was measured by using glass jar method. The four study sites were selected nearby heavy dustfall area. The study area coverby hilly ranges and varing wind velocities. The four study sites were as follows:

Figure 1: Determination of Dustfall in study area

1) Site No. 1 covering Khadi Machines Chouk, under Katraj-Kondwa Range, is connecting roads toward Katraj, Kondwa, Yewalewadi and Hadpsor bypass road which shows heavy trafic loads.
2) Site No. 2 covering North Yewalewadi , which is ideal home crushing units under an area of 3 Km^2. Around 30 crushering units are continuously running in this area.
3) Site No. 3 is selected as Wadachiwadi which is on Hadapsor Bypass road. This site is affected by two crushing units.
4) Site No. 4 was selected at Trinity College of Engineering, located at 3 Km next to Yewalewadi in Bopdev Ghat.

The entire selected four sites are under heavy dust pollution since many years. The geological investigation of Katraj region had shown the occurrences of different rock beds basalt. The formation of soil due to weathering is the long process of environmental evolution. The change in atmospheric parameters such as temperature, rail fall, humidity etc. leads to weathering process. The selected study areas have a tropical climate. Normally rain falls during rainy season and few weeks of winter sometimes. The annual average temperature of study area is 24.4 °C which is almost suitable for good living condition and safely environmental. The highest average temperature is around 28.9 °C which is normally recorded in summer season during May. The lowest average of annual temperature is at around 20.8 °C, recorded for winter season in December. The average rainfall for selected study area is 872 mm. The higher rain falls occur during July-August of every year. The average maximum precipitation during this duration is an average of 276 mm. January onward, the precipitation goes on decreasing. The air quality index of Katraj is found to be almost moderate during July month with an average 74. The pollutants contain PM_{10} as a major pollutant in the area. The average humidity is found to be above 90 for many times during rainy season. Such beautiful weather conditions are under the influence of crushing units which are currently running at Katraj. The disintegration of rock beds during mining or crushing operations produces large dust.

3.2 Determination of Dust Pollution

The determination of dust pollution were carried out for continues 7-8 weeks of post winter and early summer in selected study area. The several stations were selected to determine the dustfall rates for that particular area. The dust pollution was measured by using glass jar method. In this method, glass jar were placed at different locations in selected study sites to collect the dust. Glass jar of 10 cm opening diameter and 15 cm height were chosen for the experimentation. Glass jar were labelled as A1, A2 for site 1; B1, B2 for site 2; C1, C2 for site 3 and D1,D2 for site 3. In the beginning of the experimentation the glass jar were dried and weighted to know the initial weight of glass jar. The initial weights were noted before placing the glass jar at study locations. The glass jars were placed at different sites at height 12-15m above ground level and the initial time of placing were recorded. Dust emitted by 25-30 crushing units situated at South Katraj results heavy dust pollution. Free fall of dust particles were allowed to accumulate in pre-weighted glass jars to determine the dust fall rates per hour. The measurement of dust pollution was carried for number hours continuously without disturbing the glass jars. Final weights and closing time of glass jars were recorded at the time of terminating the experimentation. The total dust fall in study area were calculated by deducting initial weights from final weights of glass jars.

The daily determination of dustfall was expressed as g / m^2 day as the glass jars were exposed to open atmosphere for 24 hours.

$$PM\ Dust\ fall\ \left(\frac{g}{\mathrm{m}^2\ day}\right) = \frac{PM\ mass\ (g)\ x\ 1}{\pi r^2\ \mathrm{x}\ 24}$$

Where (πr^2) is the cross sectional area of the jar mouth in m^2, 1 is one day duration of dust fall testing, 24 are the actual duration in hours for which glass jar was exposed[8].

The dustfall was calculated for every week at different stations to understand the flow of dust pollution in selected study area.

4. Results and Discussion

4.1 Dust Pollution

The dustfall recorded in a selected study area were found to be unpredictable. The effect of crushing units can be judged by reading the below drafted tables.

Table No. 1 shows the dustfall recorded for two locations, selected at four different sites. The lowest dustfall was found at Site 4, sampling location 2, which was equal to 21.97 g/m^2 day. The lower dustfall at Site 4 is due to its elevation. Site 4 is situated at higher altitude as compare to other three sampling sites. It is closer to crushing units but, due to higher altitude, coarser dust particles start settling due to gravity before reaching to the Site 4.

Heavy dust pollution was observed at Site 3 near Wadachi Wadi village. This area is covered by hilly ranges at South end which is the ideal home crushing units. The dustfall recorded for this area was 51.27 g/m^2 day and 51.91 g/m^2 day at C1 & C2 respectively. The locations A1 and A2 of Site 1 are situated Khadi Machine. It is at far distance from crushing units but it is a heavy traffic junction and hence it has shown higher dust pollution than Site 4.

Table 1: Determination of Dustfall (g/m^2 day) by glass jar method

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)	Dustfall (g/m^2 Day)
1	A1	336.02	11:30 AM	11:30 AM	24	337.12	1.1	35.03
	A2	328.01	11:30 AM	11:30 AM	24	329.24	1.23	39.17
2	B1	330	12:15 PM	12:15 PM	24	331.3	1.3	41.40
	B2	335	12:15 PM	12:15 PM	24	336.32	1.32	42.03
3	C1	331.31	12:45 PM	12:45 PM	24	332.92	1.61	**51.27**
	C2	332.32	12:45 PM	12:45 PM	24	333.95	1.63	**51.91**
4	D1	330.01	10:15 AM	10:15 AM	24	330.8	0.79	25.15
	D2	330.01	10:30 AM	10:30 AM	24	330.7	0.69	21.97

Table 2: Determination of Dustfall (g/m^2 day) by glass jar method

Site No.	Total Dustfall (g / m^2 Week)							Average Dustfall (g/m^2 WEEK)
	Week Number							
	1	2	3	4	5	6	7	
1	218.20	222.10	228.32	185.20	215.25	224.30	229.36	217.53
	215.20	218.60	221.25	180.25	216.20	221.10	226.20	214.11
2	230.30	232.23	246.11	218.28	241.24	266.50	289.81	246.35
	235.20	240.36	247.23	210.23	237.60	280.43	294.27	249.33
3	340.22	342.01	345.20	240.15	332.23	342.90	358.92	**328.80**
	350.30	354.25	362.10	262.23	348.50	362.20	386.2	**346.54**
4	136.25	139.40	147.50	120.01	138.50	158.60	176.11	145.20
	121.23	124.36	126.45	105.20	118.25	138.53	153.82	126.83

The average dustfall measured in study area were found to be more than 125 g/m^2 week for all sites. The dustfall rate was found to be more in summer than winter season as the temperature gradually increased in week no 7. The no. 2 shows the average dustfall measured for 7 weeks. The highest average dustfall were obtained for site 3 which is surrounded by two clusters of crushing units. The heavy vehicular traffic on unpaved routes is the main reason for huge dust oscillations.

Table 3: Percentage Drop in Dustfall due to raining

Site No	Dustfall	Dustfall (g / m^2 week)		% Drop In Dustfall Due Raining
		WEEK NUMBER		
		3	4	
1	A1	228.32	185.2	18.89
	A2	221.25	180.25	18.53
2	B1	246.11	218.28	11.31
	B2	247.23	210.23	14.97
3	C1	345.2	240.15	**30.43**
	C2	362.1	262.23	**27.58**
4	D1	147.5	120.01	18.64
	D2	126.45	105.2	16.81

The dust emission can be prevented by application of water as it is proved from Table no. 3.The dustfall rate was found to be decreased due to raining in study area during week no.4. The percentage drops in dustfall quantities were found to be highest for Site no.3. The rained water suppressed the oscillations of dust particles from unpaved roads and the drop in dustfall values were 30.43% and 27.58% which was almost double of the drop in dustfall values observed for other sites.

Table 4: Percentage rise in Dustfall due to rise in temperature

Site No	Dustfall	Dustfall (g / m^2 week)		% Rise In Dustfall Due to rise in Temperature
		Week Number		
		1	7	
1	A1	218.2	229.36	5.11
	A2	215.2	226.2	5.11
2	B1	230.3	289.81	25.84
	B2	235.2	294.27	25.11
3	C1	340.22	358.92	5.50
	C2	350.3	386.2	10.25
4	D1	136.25	176.11	**29.26**
	D2	121.23	153.82	**26.88**

The rise in dustfall rate was observed as the local temperature of area raised from week no. 1 to week no. 7. The highest % rise in dustfall values was obtained from Site no. 4 at it is situated nearer to crushing unit.

5. Conclusion

1) As the survey of NAAQs had stated, more than 50 % cities were found at critical dust pollution level, and the same is observed at South Katraj Region. The average weekly dustfall observed at different locations have crossed the limits of ambient air quality.
2) The highest values of dustfall measured at Site 3 were more than 350 g / m^2 week many times which indicates the heavy dust pollution of the area.
3) The dust emission rate goes on increasing as the temperature of surrounding increases is proved by this experimentation.
4) The Application of water can minimize the dust emission as it has proved from the results obtained in week number 4.

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