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A Study on the Correlation Analysis between the Daily Earthwork Volume and Fine Dust Concentration

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Abstract

Purpose: Fine dust is classified as a group 1 carcinogen and poses a significant environmental problem that urgently requires improvement to protect the environmental rights of citizens. Given the difficulty of implementing measures to reduce overseas sources of fine dust, it is essential to first devise specific measures to address domestic emission sources. As such, this study aims to analyze the correlation between earthwork volume control and fine dust concentration as preliminary management measures to reduce the impact of scattering dust at construction sites. Based on real-time air quality information, field management measures will be presented to mitigate the effects of dust emissions. **Research design, data and methodology:** As examples, we selected construction sites that had recently undergone small-scale environmental impact assessment consultations. The standard earthwork volume was classified into grades using 20% intervals, and we applied AERMOD to predict the weighted concentration of fine dust based on the earthwork volume class and analyzed its correlation. **Results:** The results of this study demonstrate a strong correlation between earthwork volume and fine dust concentration. By utilizing the correlation analysis between earthwork volume and fine dust concentration on-site, this finding can be utilized as an effective fine dust management plan. **Conclusions:** This involves determining the daily earthwork intensity based on real-time air quality information and implementing measures to reduce scattering dust.

Keywords : Fine Dust, Environmental Impact Assessment, Earthwork Volume, Construction Site

JEL Classification Codes : I30, I31, I38

1. Introduction

Fine dust, designated as a first-tier carcinogen by the World Health Organization (WHO), has a negative impact on the healthy lives of the people, and the government has established and implemented continuous management measures for fine dust as a priority.

As a result of a joint study with NASA, 48% of foreign influences such as China and 52% of domestic emissions were analyzed from May to June 2016, and it was reported

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that foreign influences were dominant in winter and spring by season and relatively domestic influences in summer.

Therefore, the central and local governments are implementing various measures to reduce fine dust, such as enacting special laws on fine dust, establishing comprehensive fine dust management and implementation plans, and establishing emergency reduction measures for high concentrations of fine dust.

As for fine dust management measures for domestic emission sources, especially construction sites adjacent to residential areas, follow-up measures such as operating dust prevention nets and spray facilities, installing washing and washing facilities at the entrance and exit of construction vehicles, and operating spray vehicles are being intensively implemented.

However, in order to obtain more effective results, it is necessary to actively introduce a preliminary management plan, and earthwork volume control, which is an absolute factor among the causes of scattering dust during construction, may be a representative example.

Since the fine dust problem continues to increase in Korea, a number of studies have been conducted on the cause of fine dust emissions at construction sites, air quality prediction modeling, and various reduction measures to reduce emissions.

However, it is true that there was a lack of a model to adjust the daily earthwork strength based on real-time air quality information at construction sites and implement measures to reduce scattering dust.

Therefore, this study reviewed the earthwork volume control plan that can comply with environmental standards, analyzed the correlation between earthwork volume and fine dust concentration, and suggested an efficient scattering dust management plan for construction sites.

2. Research Methodology

2.1. Selection of the Target Site and Standard Earthwork Volume for the Development Project

The development project for this study applied the case of "Small Environmental Impact Assessment (2020.02) for the Pocheon Facility Movement ○○ Warehouse Creation Project", which has a large number of residential areas among the recently completed small-scale environmental impact assessment consultations.

In addition, the standard earthwork volume was 100% of the estimated earthwork volume calculated through the civil engineering design of the project, and the earthwork volume control was classified at 20% intervals, and 50% of the earthwork volume was additionally included.

2.2. Conducting Impact Prediction through Air Quality Modeling

Air quality modeling applied AERMOD, which has a lot of performance in the domestic environmental impact evaluation process, and average weather data for the past 10 years (2010-2019) of the Seoul Meteorological Observatory adjacent to the development project target site were applied.

As for the weather conditions, the Seoul Meteorological Observatory's average weather data and Osan high-rise weather observation network were applied over the past 10 years, and the topographic data were calculated with a grid size of 100m×100m.

The emission sources applied to AERMOD were the fuel use of construction equipment, the movement of dump trucks and other equipment in the workplace, and the loading and unloading of soil.

Emissions from each emission source were calculated by applying the standard calculation formula for construction work and the emission coefficient of the National Institute of Environmental Research. In addition, EPA's emission coefficient was applied to emissions from the movement of construction equipment without domestic emission coefficients.

2.3. A Study on the Change in Air Quality by Controlling the Earth's Air Quality

As previously described, air quality modeling was performed by setting the standard earthworks to 100% and applying the earthworks to 20% intervals (including 50%), and the weighted air quality concentrations for each earthworks section were predicted and organized into tables.

The standard earthwork volume was applied as a 12-month intensive earthwork period from the total earthwork generated according to the project plan, and one month was calculated as 25 days and converted into earthwork work.

Furthermore, the study assumed that the daily working hours would be eight hours, from 9 a.m. to 6 p.m., excluding lunch breaks, and that the amount of earthwork performed during each eight-hour period would remain consistent.

Table 1: The Amount of Earthwork during Construction of the Target Site of the Development Project

Sortation	Total earthwork volume(㎥)			daily earthwork volume(㎥)			note
	a subtotal	Shaving	Stacking	a subtotal	Shaving	Stacking	
earthwork volume100%	201,129	184,008	17,121	670.4	613.4	57.1	
earthwork volume80%	160,903	147,206	13,697	536	491	46	
earthwork volume60%	120,677	110,405	10,273	402	368	34	
earthwork volume50%	100,565	92,004	8,561	335	307	29	
earthwork volume40%	80,452	73,603	6,848	268	245	23	
earthwork volume20%	40,226	36,802	3,424	134	123	11	

2.4. Receptor Selection

As for the target site of the development project, five residential areas distributed within 500m of the target site were applied.

Table 2: Current Status of the Receptor around the Project Construction Site

Sortation	TM coordinates		distance (m)	note
	x	y		
receptor1	212,356	584,799	Adjacent to	
receptor2	212,399	584,767	36	
receptor3	212,470	584,529	286	
receptor4	212,746	584,743	289	
receptor5	212,569	584,867	70	

3. Research Results

3.1. Air Quality Modeling Results

3.1.1. Air Quality Modeling Basic Input Material

As for the weather conditions, average weather data and Osan high-rise weather observation network were applied over the past 10 years, and topographic data were calculated as 100m×100m grid size.

3.1.2. The Results of Air Quality Modeling Based on Earthwork Volume Control

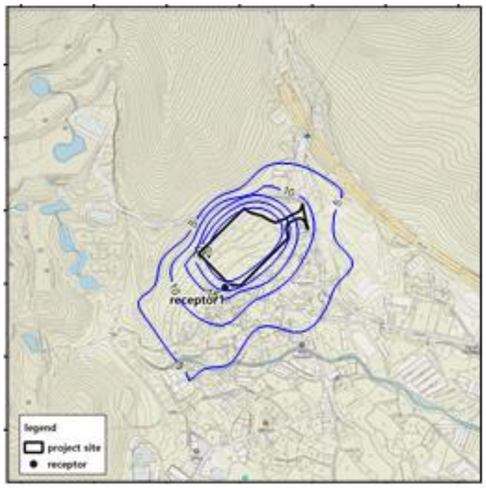
When the amount of earthwork is adjusted step by step during construction, the fine dust concentration is predicted to increase by PM-10 0.4 to 22.6㎍/㎥ and PM-2.5 0.4 to 20.4㎍/㎥.

Considering that the environmental standards are PM-10 100㎍/㎥, and PM-2.5 35㎍/㎥, it can be seen that if the daily earthworks are carried out without control, the current concentration may exceed the environmental standards.

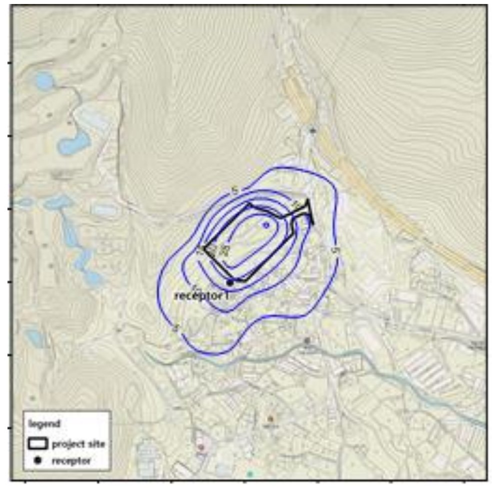
Therefore, during the period when the predicted concentration, including the current concentration, is expected to exceed the environmental standards, measures should be implemented to reduce daily earthwork volume and reduce scattering dust by extending the earthwork.

Table 3: Prediction Results of Air Quality Weighted Concentration According to Earthwork Volume Control

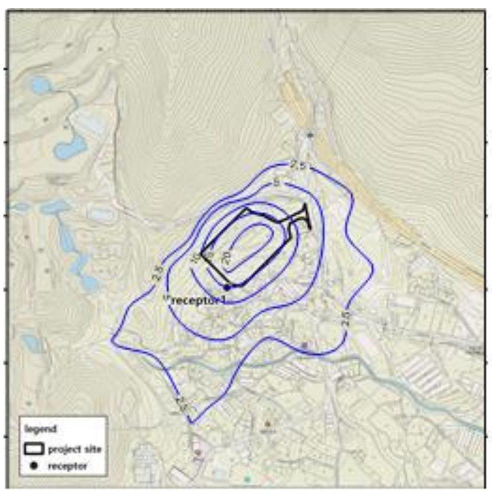
Sortation	TM coordinates		earthwork volume	Weighted concentration		note
	x	y		PM-10 (㎍/㎥)	PM-2.5 (㎍/㎥)	
receptor1	212,356	584,799	100%	22.6	20.4	
			80%	18.1	16.3	
			60%	13.7	12.3	
			50%	11.3	10.2	
			40%	9.1	8.2	
			20%	4.6	4.1	
receptor2	212,399	584,767	100%	14.4	13.0	
			80%	11.5	10.4	
			60%	8.7	7.8	
			50%	7.2	6.5	
			40%	5.8	5.2	
			20%	2.9	2.6	
receptor3	212,470	584,529	100%	2.1	1.9	
			80%	1.7	1.5	
			60%	1.3	1.1	
			50%	1.0	0.9	
			40%	0.8	0.8	
			20%	0.4	0.4	
receptor4	212,746	584,743	100%	3.1	2.8	
			80%	2.5	2.2	
			60%	1.9	1.7	
			50%	1.6	1.4	
			40%	1.2	1.1	
			20%	0.6	0.6	
receptor5	212,569	584,867	100%	10.5	9.4	
			80%	8.4	7.5	
			60%	6.3	5.7	
			50%	5.2	4.7	
			40%	4.2	3.8	
			20%	2.1	1.9	



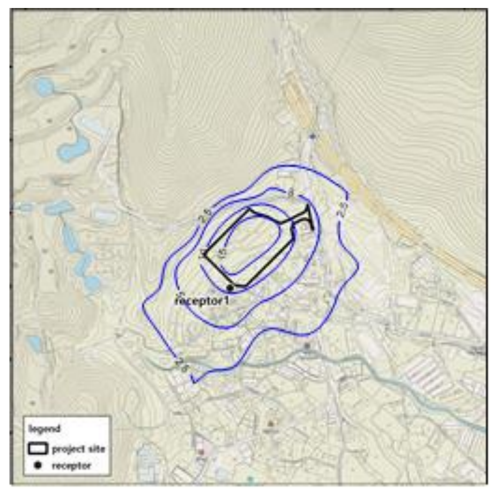
earthwork volume 100%



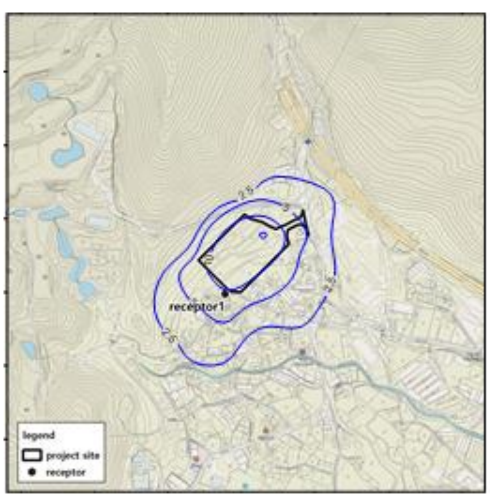
earthwork volume 80%



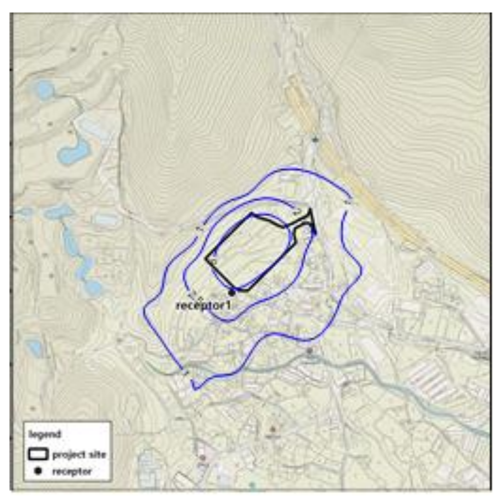
earthwork volume 60%



earthwork volume 50%



earthwork volume 40%



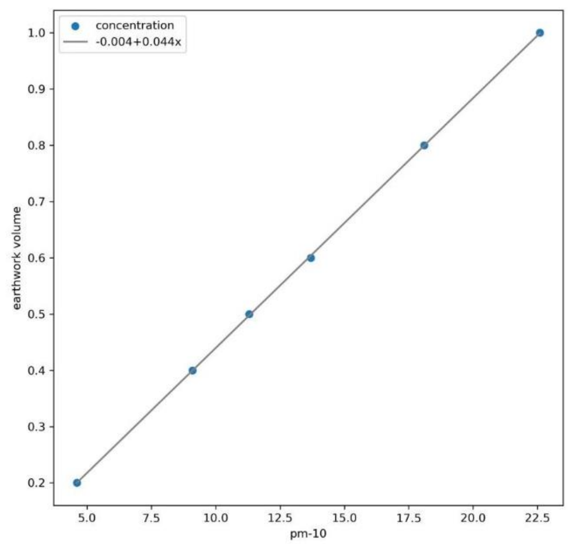
earthwork volume 20%

Figure 1: Prediction Results of Air Quality (PM-10) in Construction by Earthwork Volume(receptor1)

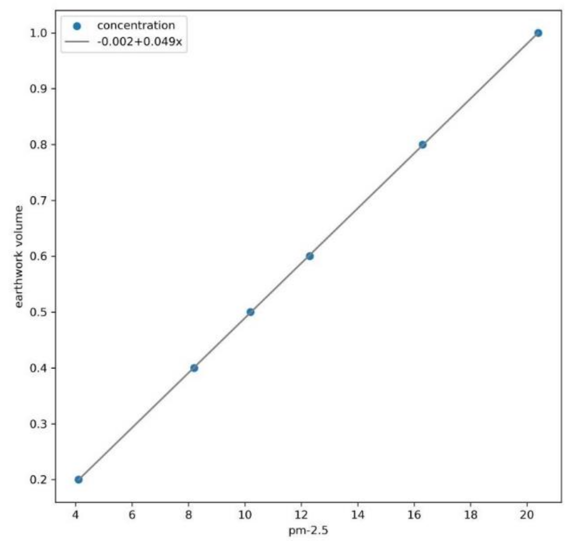
3.1.3. Correlation Analysis

As a result of air quality modeling, the change in earthwork volume and fine dust concentration showed a strong positive correlation with r(correlation coefficient) value of 0.9999, and the correlation coefficient between the earthwork volume reduction rate and fine dust concentration was determined to be statistically significant.

Meanwhile, using the correlation graph below, it is possible to apply the process of determining the weighted concentration level of fine dust and determining the appropriate daily earthwork volume to the construction site to comply with the environmental standards.



Relationship between pm-10 and earthwork volume



Relationship between pm-2.5 and earthwork volume

Figure 2: Correlation Analysis Results(receptor1)

4. Conclusions

In order to manage fine dust caused by scattering dust generated at construction sites, this study analyzed the correlation between earthwork volume and fine dust concentration, and presented a methodology to maintain environmental standards.

It is expected to be an effective fine dust management plan if the results of the analysis of the earthwork volume and fine dust concentration considering the construction site conditions are provided on the site, the daily earthwork intensity is determined based on real-time air quality information, and measures to reduce scattering dust are combined.

On the other hand, as explained in the beginning, since the source of fine dust is relatively high in foreign countries, it may be difficult to achieve the effect that the public will feel in spring alone.

However, as environmental standards in foreign countries, especially China, continue to be strengthened and the supply of eco-friendly cars is rapidly increasing, efforts should be made to reduce domestic fine dust sources that can be accessed immediately.

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