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Public Building Design Criteria for Groups Sensitive to Fine Dusts
- Focusing on Day Care Centers, Kindergartens and Elementary Schools -

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SUMMARY

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We are now faced with the situation of having to search for assertive response plans and close management of fine dusts due to the rapidly changing domestic and international climate environment. The general fine dust management plans according to the Special Act on the Reduction and Management of Fine Dust sets improving the base for protecting the health of sensitive and vulnerable groups as its main goal, but it stops short at fragmental achievements. Under such circumstances, preferential measures for public architecture used by groups sensitive to fine dusts are essential in terms of spatial welfare, but the public architecture facility plan standards lack detailed guidelines considering fine dust conditions.

This study aims at providing customized facility planning standards reflecting the behavior features of infants, young children, and elementary students, and by facility. The purpose of this study is as follows. It aims at providing a pan-government integrated facility planning standards for response policies related to fine dusts and standards per facility that are being implemented separately by each government agency. Another purpose of this study is to provide integrated facility planning standards for

collaboration in various fields such as architectural plans, facilities, environment, and facility operational management. The scope of the contents for the research is to present planning standards for educational and play activity spaces, which are the primary activities of day care centers, kindergartens, and elementary schools, and it also aims at providing planning standards reflecting technological research in relevant fields such as building interior air quality management, fine dust reduction technologies, and urban micro-climate management.

The fine dust environment standards were raised to levels of advanced nations (annual average $15\mu\text{g}/\text{m}^3$, daily average $35\mu\text{g}/\text{m}^3$), and therefore, facilities that are required to install mechanical ventilation equipment were expanded to nursing homes with a total floor area of $1,000\text{m}^2$ or larger, small movie theaters and new apartment buildings with more than 30 units according to the 'Rules on Facility Standards, Etc. of Buildings' and relevant laws were revised to recommend installation of ventilation facilities for apartments with less than 30 units and detached houses as well.

Various policies are being found and operated to protect the health of the sensitive and vulnerable classes through not only general fine dust management plans and the basic indoor air quality management plans, but also by local governments nationwide. Accordingly, air purification equipment are being installed in all kindergartens and schools nationwide and air purification equipment support for facilities used by sensitive groups such as young children, senior citizens, and the disabled are being expanded. However, while there are local governments that install and manage sensors that measure and monitor indoor air quality in real-time, there are some local governments that stop short at simply providing support for operational expenses for air purification devices, and therefore, there are differences in terms of contents and levels of support per region.

Day care center and school facility fine dust response manuals require the prescription of standards according to limited, shortened or restricted outdoor classes and to plan alternatives in advance. However, under the current conditions, it is difficult to use limited space such as indoor gyms or auditoriums for all students without inconveniences. A systematic alternative is needed to overcome the fundamental limitations by relevant institutes or supervising institutes such as providing appropriate space for accommodating indoor activities.

Results of surveys with sensitive groups and administrators showed that there is relatively high opinion that government policies on fine dusts focus on response, and there was high levels of opinion that there is deficiency in evaluating policies. While response policies for high concentration fine dusts are important, a paradigm shift to policies for prevention is also needed. Therefore, from this perspective, construction or remodeling guidelines and facility planning standards, etc. for facilities mainly used by sensitive groups can be viewed as a preventive approach method to mitigate fine dusts.

Supply of air purifiers has been completed to most facilities through relevant laws and policies and support projects, but there are huge differences in terms of the management status of air purifiers and actual indoor air quality values. More fundamental measures, preemptive response and systematic improvement plans should be sought after going beyond the stage of simply supplying air purifiers. From this aspect, providing facility planning standards for groups that are sensitive to fine dusts have become very urgent.

Excluding recently built new buildings, it is difficult to keep indoor air quality in all of the spaces within a facility pleasant. The sizes of facilities are all different and the occupation time and usage method for each room are also different. In addition, the difference in the level of managing indoor air quality per facility is quite significant for each facility due to the differences in child care and education courses. Under such circumstances, a strategy that first differentiates spaces needing management and conducting maintenance selectively is needed. And in the case of newly built facilities, while it is possible to apply effective and high performance central control-type air purification devices, etc., over 90% require renovation of the indoor environment through remodeling, etc. of existing buildings. Furthermore, the budget for this is limited and therefore, plans that combine or gradually apply natural ventilation methods, methods of using air purifiers, stand-alone methods, and central control methods should be devised. Also, as it is necessary to satisfy a certain amount of ventilation according to the relevant laws and regulations, while also maintaining indoor air quality under a certain level in terms of fine dust, formaldehyde, carbon dioxide, carbon monoxide, etc., air purifiers, ventilation devices, or ventilation methods should be considered comprehensively.

Upon verification through on-site investigations and surveys, it is necessary to consider in the order of care rooms (classrooms) and indoor playgrounds for day care centers and

kindergartens, and in the case of elementary schools, there is a slightly difference in that priority management is needed in the order of classrooms, restaurant, after-school classrooms, and special classrooms.

Upon analyzing through preliminary studies and on-site investigations, the indoor air quality of most facilities are highly associated with the fine dust count in the air and it is also evident that facilities that do not manage indoor air quality are more highly affected by the concentration of outdoor air. It is thus necessary to actively mitigate floating fine dusts in the air or use absorption equipment to apply in the outdoor spaces within the building grounds.

When installing air purifiers in day care centers, kindergartens or elementary schools, detailed performance standards and information are needed for actual application such as filter specifications to manifest appropriate performance or the ventilation capacity and waste heat collection performance conditions of air conditioning facilities. Furthermore, it is necessary to review the appropriate specifications for air shower anterooms, window and door tightness performance, and energy efficiency performance standards to prevent inflow of external pollutants through main entrance ways.

The basic directions for establishing basic facility standards are as follows. In addition to fine dust response (avoidance) from a long-term aspect, it is necessary to set facility planning directions for mitigation (prevention) and also to provide facility standards for all stages in the life cycle (planning, design, construction, operation) of buildings. Lastly, it must be inclusive of new construction planning standards and its remodeling standards for facilities for groups sensitive to fine dusts.

Facility planning standards are comprised by location and outdoor space standards, area standards, zoning standards, building performance standards, and facility operation management standards, and the details and contents of each standard were deduced for the initial items based on case studies and planning standard analyses of each facility. The need and importance per item were sorted based on surveys and a seven-person task force comprised of experts in policies, urban and regional sectors, architecture, and facilities was organized and using the detailed values of the provided planning standards, additional surveys were conducted on 39 experts in the fields of architectural planning, urban planning facilities, and eco-friendly sectors to verify the appropriateness of performance standard indicators. In addition, the level of usability

and effectiveness of planning standards were predicted through planning simulations and environmental facility network simulations.

Results of the network simulation (CONTAM program) for predicting the effectiveness of facility planning standards quantitatively verified the improvement effects of indoor air quality per care room of the target facilities. It was effective when applying the planning standards individually, but it was found that the improvement effects of indoor air quality were much greater when applying together.

Based on the provided standards, simulations applying the designs were conducted to examine its effectiveness. In new projects, 10 out of the 14 items could be applied, and while the detailed items were different, 10 standards could also be applied for remodeling projects of existing buildings. Through this, it was possible to predict that usability in all new construction projects and renovation projects.

The detailed public building facility planning standards for groups sensitive to fine dusts are as follows.

[Table] Detailed public building facility standards for groups sensitive to fine dusts

Section		Item	Contents	Detailed Standards
By Location and Outdoor Space	Response	Distance from streets to avoid and prevent inflow of external fine dusts	Keep distance from streets to minimize inflow of external pollutants to maintain pleasant indoor environment	At least 50m from large roads with high traffic volume
	Mitigation	Install double-layer vegetation Install outdoor air purification facilities	Install outdoor air purification devices and install vegetation in double-layer structure to mitigate and absorb external fine dusts near the building	Install near the main entrance
By Area	Mitigation	Upward adjust appropriate area standards compared to no. of persons for day care centers and school facilities	Procure extra indoor activity space and consider adjustment of occupying personnel per area to improve performance efficiency of air purifier equipment	Facility area standards are appropriate to upward adjust 2~4% for existing area standards
By Zoning	Response	Plan buffer space for polluted air at the entrance part	Procure buffer space to minimize inflow of fine dusts on the body or clothes when entering from outdoors	Install around 1% of entire facility area and more than a size of 10m ²
		Install fine dust clean zone	Alternative space to switch outdoor activities to indoor activities according to occurrence of highly concentrated fine dusts, etc. Example) Procured 1 clean zone per 6 classes	For day care centers and kindergartens, procure clean zones in the order of care rooms (classrooms), indoor playgrounds, cafeterias, and elementary schools in the order of classrooms, cafeterias, and indoor playgrounds, and at least 15m ² for day care centers,

Section	Item	Contents	Detailed Standards
		Divide internal fields considering fine dust occurrence	Kitchens, cafeterias, special activity rooms, gyms, etc. where there is high occurrence of fine dusts separated from other areas with less occurrence
			Priority fields to be zoned for day care centers and kindergartens are in the order of care rooms (classrooms), indoor playgrounds, and cafeterias, and necessary to set priority zones to zone in the order of classrooms, cafeterias and indoor playgrounds for elementary schools
By Building Performance	Response	Based on material performance for strengthening air tightness	Materials with high air tightness and thermal transmittance should be applied for windows and doors to block inflow of external fine dusts Need to use products with grade 2 or higher thermal transmittance and grade 2 or higher air tightness
		Based on ventilation facilities and air purifier performance	Need to separately install ventilation facilities and air purifiers for general management of indoor air quality or install equipment with compound functions Present standards for ventilation method (buried type, independent type, etc.) according to appropriate capacity of ventilation equipment per hour for each facility
	Mitigation	Planning considerations	Outdoor ventilation equipment locations should be installed in sectors where outdoor polluted air is stagnant or polluted air ventilated from indoors does not return indoor
		Greenification of walls using air purification plants	Air purification plant wall greenification to adjust indoor temperature and humidity and absorb floating fine dusts
By Facility Operation and Management	Response	Ventilation and air purification facility automated activation system according to fine dust conditions	Automatic system for indoor air quality management at certain levels and convenience for operators and administrators
		Improve facility performance monitoring functions	Implement monitoring functions that can check for periods for replacing parts and cleaning
	Mitigation	Plans to prevent occurrence of polluted air and to prevent re-spreading according to indoor activities	Recommend using cleaning methods and tools with small occurrence of fine dusts (cleaning with wet rags, robot cleaners, etc.) Prevent re-spreading during cleaning, cooking and activities such as air curtains, etc.

Source: Drafted by researcher

The outcomes of this study are as follows. Based on analysis and diagnosis for the features of activities of groups sensitive to fine dusts and facility features, spaces with high usage frequency and spaces requiring priority management were deduced. For clean areas requiring concentrated management (care room, classroom, indoor play area, cafeteria), they should be zoned to prevent cross-contamination or spreading to other spaces and the area per person standard was upward adjusted to provide conditions for sensitive groups to engage in educational and physical activities in more pleasant conditions than before in low-density environments. And stronger window air tightness standards and detailed appropriate specifications of ventilation equipment and purifier equipment were proposed through environmental equipment simulations. In addition to ventilation equipment and air purification equipment conditions fitting the conditions of care rooms of day care centers, architectural alternatives that could be referred to for day care centers with similar conditions were exhibited through simulations.

Public building facility planning standards for sensitive groups proposed in the study are facility planning standards from unprecedented pan-government aspects. These are standard that include matters related to the Ministry of Environment's 'Special Act on the Reduction and Management of Fine Dust' and 'Indoor Air Quality Act', while also considering the Ministry of Education's 'School Health Act', the Ministry of Health and Welfare's 'Child Care Act' and the Ministry of Land, Infrastructure and Transport's 'Rules on Building Facility Standards, Etc.' were reviewed comprehensively to draw up optimized planning standards for groups sensitive to fine dusts. This can serve as planning standards that can be used throughout all government agencies.

Moreover, rather than being one-way planning standards focusing on experts, suggesting detailed standards through surveys with experts based on priorities and the need by sensitive groups and facility operators and administrators can be viewed as a distinctive achievement of this study. Also, based on the architectural planning simulation and architectural environment simulations, the contents that predicted usability and effectiveness are expected to serve as a basis to provide reliability to those using the research outcomes.

Keywords

Fine dust, Public buildings, Design Criteria, Indoor air quality, Planning simulation, Network simulation