The Changing Appearance of Color of Architecture in Northern City
-A Comparison Study of Architecture's Appearance in Summer and in Winter, in Sapporo City-

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Abstract
This research explores the changing appearance of color of architecture. Different seasons create different appearances. The purpose of this research is to demonstrate the changing appearance of color by comparing architecture between summer and winter in Sapporo city. The aspect of visual phenomena, such as color and light, can be understood by analyzing the appearance of architectural spaces. This research aims to clarify the phenomenon about appearance of color of architectures in northern city.

Keywords: appearance of color; cityscape; snow; urban space; color; lighting

Introduction
Architectures in cities are affected by or produce effects on their environmental surroundings and due to their location, there are few cases where we must consider only the influence of the architecture itself. However, people tend to place too much emphasis on architectures themselves rather than other effects since they are more conscious of economic aspects. The facade of architecture is an important element for humans to visually recognize the architecture. Moreover, in cities subject to heavy snow and cold temperature, architectures can not exist without taking into account the phenomenal aspect of “snow” (including precipitation, coverage and thaw).

Up to the present, most research on colors of landscape adopts conventional color space methods and only a few deals with phenomenal aspects of color. In this study, color phenomenon of architectural facade is considered as visual appearance.

D. Katz1) classified and studied appearances. Oku2) analyzed cityscape by appearances of actual architectures and systematized the appearances. Kametani3)-5) discussed the effectiveness of the concept of appearance and the application of the concept to urban planning and architectural designing. Yanagihara6), in order to explicate the change in appearance of cityscape according to time difference, studied the change in appearance of historic buildings and surrounding buildings to clarify its diversity and stability. This study attempts to grasp and clarify the changing appearance of facades of buildings in cities according to time difference in summer and in winter. Architecture in central Sapporo City are chosen as research objects. Further, we will clarify their relationship with surrounding buildings. Also, we will clarify the difference between two conditions: when covered with snow and when not, which is a unique characteristic of regions subject to snow and cold whether.

1. Method of research
1.1 Research objects
The former Hokkaido Government office building, or “Red Brick”(Fig.1-a), Sapporo Clock Tower (Fig.1-b), and APIA dome in front of sapporo station south exit(Fig.1-c), all of which are representative facilities of central Sapporo City, are the research objects. These architectures are chosen based on architectural material and location(Fig.1-d).

1.2. The way of exploration
Recording was conducted from before sunrise (from aspect starts changing (about one hour) to after sunset, until darkness stabilized (about one hour). A digital video camera was used to record the changing visual phenomena. Investigation method proposed by Yanagihara is applied, and architectural objects are filmed at intervals; standby for one minute and recording for one second. These images are extracted as still images, for which observations are made to clarify the changing appearance according to time difference. Objects are roughly divided into research architectures, surrounding architectures and road surface, whose appearances are extracted and analyzed. At the same time, images are observed one by one and any changes in appearance are listed.

1.3 Period of exploration
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1.4 Way of analysis
(1) Preparation of basic data
Based on the data gathered through recording, appearance type, as well as appearance changes, and notable points that were observed during recording were listed on data sheets (Fig. 2).
(2) Extraction of observed appearances
Observed appearances are classified according to research architectures, surrounding buildings, etc.
(3) Comparison
All data collected in summer and in winter are compared.
(4) Analysis of brightness
Brightness analysis is conducted as a method to support classified observation data. The image was selected at a time and the brightness was measured making use of NIH Image. The place where brightness changes are regarded as the part where appearance changes.

1.5 Definition of the term
Appearance of color: refers to the state of a thing or how it looks and indicates the difference in the state of things when it continuously changes. Visual appearance employed in this study refers to “mode of appearance of color” defined by D. Katz, a German psychologist and is a perceptual phenomenon. This is an interaction between physical entity and perception.

This study uses appearance of color classified by 8 subjects systematized by Kametani who analyzed OSA (the Optical Society of America), CIE (Commission International de l'Eclairage), JIS and Kametani found with D. Katz as a standard, he sorted important appearance of color while evaluating cityscape and rearranged into 35 colors, sorted with 8 characters (Table 1).
2. Research results

(1) APIA Dome (Fig. 3-a)

A. Summer

Appearances can be roughly classified into two groups: long or short average appearance duration. Reflection color and transparent surface color appear for a short duration but often, and in total, those appearances occur over a long period of time. This can be said from the fact that they have short average appearance duration with percentage of total appearance frequency and duration being high. The building’s appearances that appear continuously for a long period and those that appear intermittently for a short period but frequently so that total duration is long are observed. From this fact, it can be said that appearance of the building is largely influenced by appearances of its surroundings. At the opening of the architecture, frequency and total duration of the appearance with transparent film color, transparent surface color, luster and mirrored color are relatively high and average duration of such appearance is short. Therefore, it can be concluded that these aspects continue to appear and disappear for a long period. The change is even more significant on the curved glass surface of APIA dome. A number of appearances that change significantly are observed.

B. Winter

Likewise in summer, appearances can be classified by long or short average appearance duration. Basically, appearances change in the same manner as they do in summer. It can be understood that snow hardly sticks to the ground since road heating system is applied to the ground of the filming location. As to APIA dome, there is a tendency for the dome surface to be covered with snow when the building operations are suspended and it has been confirmed that snow melts just as the operations resume owing to heating inside the building. This dynamic shift from “snow” to “glass,” which is observed at the south exit is a unique characteristic of a region subject to heavy snow and cold air.

C. Difference between winter and summer at night

We were able to observe the lighting of the south exit reflecting onto the roof of APIA dome, and the light from the aurora vision installed in front of APIA dome reflecting onto APIA dome. There is little change in lighting during winter and summer.

(2) Sapporo Clock Tower (Fig. 3-b)

A. Summer

Continuous appearance is observed over a long time period. At the same time, many observed appearances are affected by the surrounding environment. Therefore, the overall appearance is stable, yet appearances with reflection and darkness, namely surface irradiation, luster, shadow and mirror color continue to appear and disappear as time elapses.

B. Winter

Many appearances that remain for a long period could be observed. The appearance that appears after sunrise largely changes. Further, appearances with reflection aspects, namely surface irradiation, appear intermittently during morning and afternoon. The location is subject to irradiation by direct sunlight at around noon and is largely influenced by surrounding buildings during other time periods. Little snow covers the building during winter. The snow has thawed and fallen from the building as the clock tower began operations. This is earlier than “Red Brick” building made of bricks. Surface irradiation is observed from the yard and road surface covered with snow.

C. Difference between winter and summer at night

Throughout summer and winter, reflections of trees could be observed due to the installation position of lighting equipment. The trees being deciduous, it appears brighter in winter. Further, since a filming position is set up near the lighting equipment, we were able to observe a human shadow reflecting on the wall surface of the clock tower.

(3) The former Hokkaido Government office building, “Red Brick” (Fig. 3-c)

A. Summer

Each appearance is observed in succession over a long time period. The ratio of appearance frequency of glare and white band is high and the ratio of total appearance duration is very low. Also from the fact that appearance duration is short, it can be observed that the appearance is temporary and short-termed. Therefore, the appearance is stable, with minimal change. Also, because the building is facing eastward, the appearance changes the most at sunrise.

B. Winter

Basic appearance and the appearance that has darkness are observed in succession over a long time period. Further, white band appears continuously throughout filming time. Fluorescent colors appear immediately before daybreak and from sundown until the beginning of light-up and surface-irradiation and glare appears on the road surface. These are appearances brought about due to snowfall. At night, due to the road surface being covered with snow, they could be recognized as surface color and transparent surface color.

C. Difference between winter and summer at night

Due to the installation position of lighting equipment, reflections of trees could be observed both in summer and winter. Among them are deciduous trees and thus, it appears brighter in winter since the lighting can irradiate on areas impossible during summer.
Fig. 3-a. APIA Dome
Fig. 3-b. Sapporo Clock Tower
Fig. 3-c. The Former Hokkaido Government Office Building

SUMMER

WINTER

brightness mode of appearance of color

brightness mode of appearance of color

un-catched color continuously change emphasize substance darkness reflection brightness brilliance transparency basic color

mode of appearance of color

brightness
Conclusion
1. Appearances differ between snow covering the building itself and that covering surrounding road surfaces. When snow covering the buildings itself like "The Red Brick" decrease substance because of emphasizing part of covering snow. When snow covering surrounding road emphasizes substances because of irradiating light reflects diffusely from roads.
2. Because road heating system causes snow to thaw as time elapses, the road appearance becomes similar to that when raining.
3. Overall brightness increases in winter due to light reflected on snow. This effect becomes more evident at night.
4. The characteristic of the location is observed when one appearance changes to another. This is because the light from sun is affected by building’s height, materials, surface of walls, direction and a scale of spaces.
5. Nighttime illumination emphasizes the actual condition of the lighting when illumination is applied to areas covered with snow due to the lighting effect created by snowas white screen. It creates another type of images and all types of snowfalls makes various rays.
6. The change in the appearance of architectures created by artificial illumination is all man-made and differs from that created by sunlight. Therefore the effects that causes appearance change must be dealt separately from those that occur during daytime.
7. Mode of appearance of color can classify changing appearance of face of buildings according to time difference in summer and in winter, but to clarify relationship with surroundings more deeply, research objects must be increased.

Notes
1. Persistence of vision means that previously appearance of color becomes complementary color as next appearance of it and this is physiological phenomena (Table 1).
2. Surface-complementary color means about scratch and dirty on the surface of objects, doesn’t have substantial characteristic itself, but the substantial characteristic of the object is emphasized by containing it (Table 1).
3. NIH Image is a public domain image processing and analysis program. It was developed at the Research Services Branch (RSB) of the National Institute of Mental Health (NIMH), part of the National Institutes of Health. Image can acquire, display, edit, enhance, analyze and animate images. It reads TIFF, PICT, PICS, providing compatibility with many other applications, including programs for scanning, processing, editing, publishing and analyzing images. It supports many standard image processing functions, including contrast enhancement, density profiling, smoothing, sharpening, edge detection, median filtering, and spatial convolution with user defined kernels. In this case, this study uses a function of measuring brightness.

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