CLASSIFICATION AND EXPERIMENTATION FOR THE DEVELOPMENT OF DAYLIGHTING SYSTEMS IN COLD AND SNOWY REGIONS

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Background_1

- Over the past 10 years, architects, researchers, and engineers have been developed the building envelope for controlling daylight such as lightshelf and louvers.
- In addition to establishing comfortable brightness for occupants, daylighting systems also reduce electric power consumption as well as passive heating and cooling systems in buildings.

Earth Port -Tokyo Gas, 1996, Yokohama, JAPAN

Source from Tokyo Gas Co. Ltd, 1997

Background_2

- Nevertheless, installing daylighting systems in cold and snowy regions has not yet widely practiced.
- One reason is thought that the daylighting systems have been developed without considering cold climate with snow coverage.
- Developed newly daylighting systems will be able to utilize not only downward daylight from the sun and the sky but also reflective daylight from snow surface effectively.

Procedure

1. Classification of Daylighting Systems

A classification system from various daylighting systems in the world from literature.

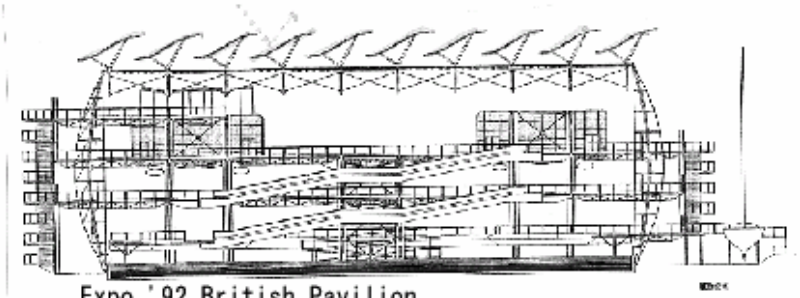
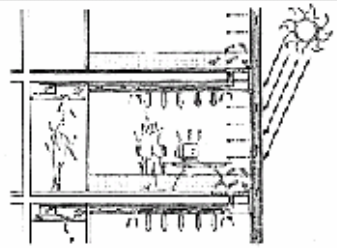
2. Experimentation of indoor Illuminance

A luminous measurement in the actual scale model which has typical opening.

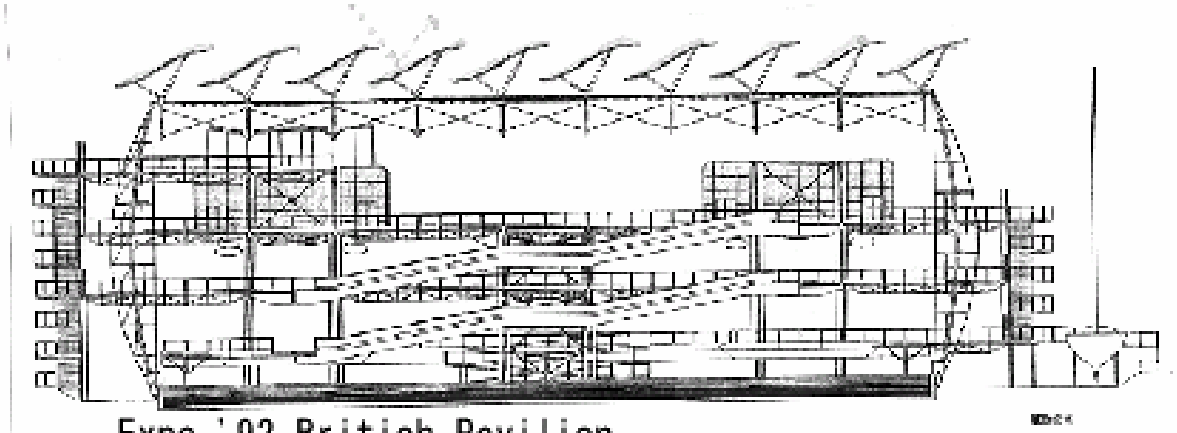
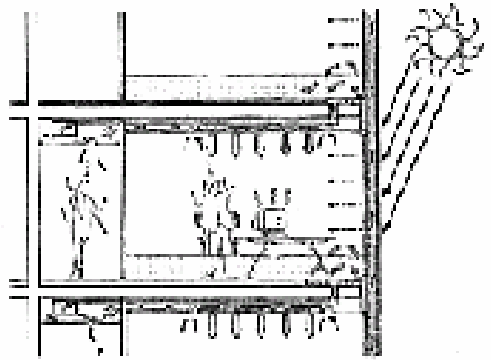
3. Proposal

Sectional examples of daylighting systems in Sapporo (N 43 deg.) are briefly proposed.

1. Classification of Daylighting Systems

Sections	Examples
Upper surface	 Expo '92 British Pavilion, Grimshow & partners, Sevilla, Spain, 1992 Shading and reflecting systems above the glass roof
Vertical surface	  Micro Electronics Park Business Promotion Center Foster & partners, Duisburug, Germany, 1996 Triple grazed windows with inner horizontal louvers
Whole surface	 New Trade Fair Hall Von Gerkan, Marg & partners in collaborate with Ian Rithie architects, Leipzip, Germany, 1996 Glass with printed strips
Lower surface	No data

Sources from ECO TECH ,Thames & Hudson Ltd, UK

Sections	Examples
Upper surface	 Expo '92 British Pavilion, Grimshow & partners, Sevilla, Spain, 1992 Shading and reflecting systems above the glass roof
Vertical surface	  Micro Electronics Park Business Promotion Center Foster & partners, Duisburug, Germany, 1996 Triple grazed windows with inner horizontal louvers

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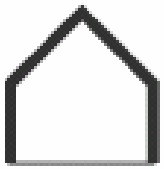
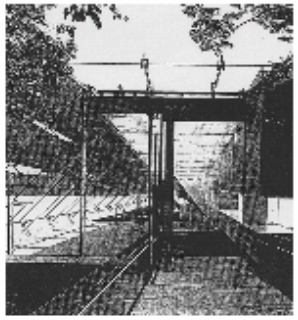
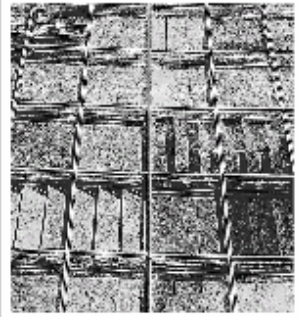
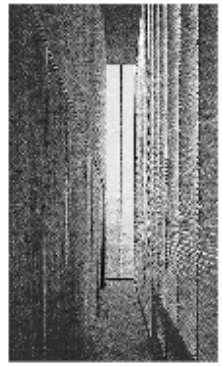
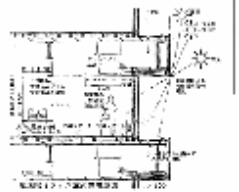
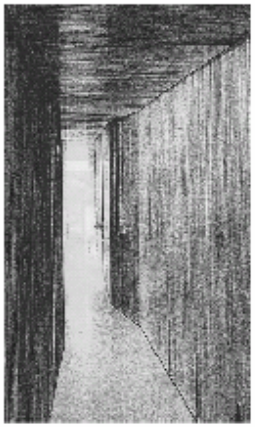
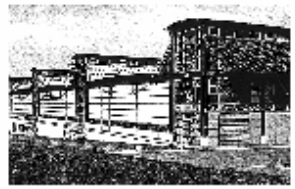
 Whole surface	 New Trade Fair Hall Von Gerkan, Marg & partners in collaborate with Ian Rithie architects, Leipzip, Germany, 1996 Glass with printed strips
 Lower surface	No data

The Great Court

London, UK

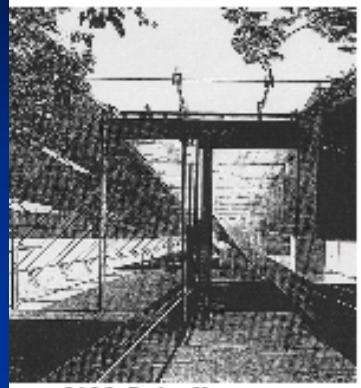
Hokkaido Northern Regional Building Research Institute, 2002
Asahikawa, JAPAN

Simple grazing	Inside	Outside	Penetrated	Integrated	Multi grazing
 GA06. Pola Museum Large windows Kanagawa, Japan	 AJ02. Rodover City Hall adjustable louvers Denmark	 KK01. Stone Museum Louvers of Stone strips , Japan		 AU03. GSWHeadquarters Integrated vertival louvers Berlin, Germany	 BS01. House in Okayama Multi layer of Policarbonate sheets Tokyo, Japan
	Control	 BS10, Administration Buillding inWiesbasden adjustable eaves Germany	 DT10. White Office Light Duct		
 AU07. Laminate Laminates glass sections reflacting Leerdam, Netherlands	 GA08. Rokkatei Makomanai Hall Vertical louvers serve as acoustic reflectors Hokkaido, Japan	 GA04. Institute for Grobal environmental strategies Light shelves in outside of windows, Japan	 ET06, British Inland Revenue Eaves, London, UK	  ET03. Wilkahn Industory Double Grazing with sandwiched insulation Germany	

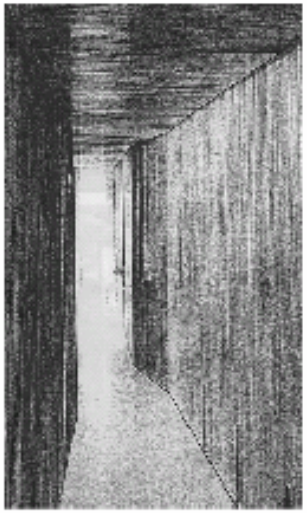
Sources from

ET:ECO TECH , Thames & Hudson Ltd, UK
AU:a+u, a+u, Japan
DT:Detail, Shokoku-sha, Japan
BS:Building Skins, edition DETAIL, Germany
GA:GA JAPAN, ADA edita Tokyo, Japan
KK:Kuma Kengo, Shokoku-sha, Japan
AJ:Arne Jacobsen, Edition GG, Spain

Simple grazing



GA06. Pola Museum
Large windows
Kanagawa, Japan



AU07. Laminate
Laminates glass sections
reflacting
Leerdam, Netherlands

Inside

AJ02. Rodover City Hall
adjustable louvers
Denmark

Control

GA08. Rokkatei Makomanai
Hall
Vertical louvers serve as
acoustic reflectors
Hokkaido, Japan

Outside

KK01,
Stone
Museum
Louvers of
Stone
strips
, Japan

BS10, Administration
Buillding inWiesbasden
adjustable eaves
Germany

GA04.
Institute for Grobal
environmental strategies
Light shelves in outside
of windows, Japan

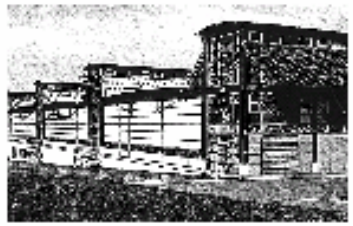
Penetrated

DT10. White Office
Light Duct

ET06, British Inland
Revenue
Eaves, London, UK

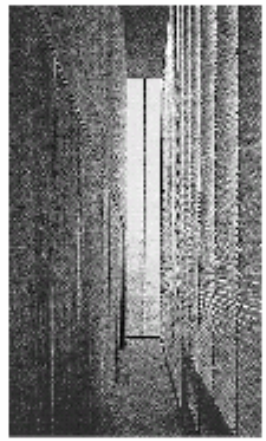
Integrated

AU03. GSWHeadquarters
Integrated vertival louvers
Berlin, Germany



ET03.
Wilkahn Industory
Double Grazing
with sandwiched
insulation
Germany

Multi grazing

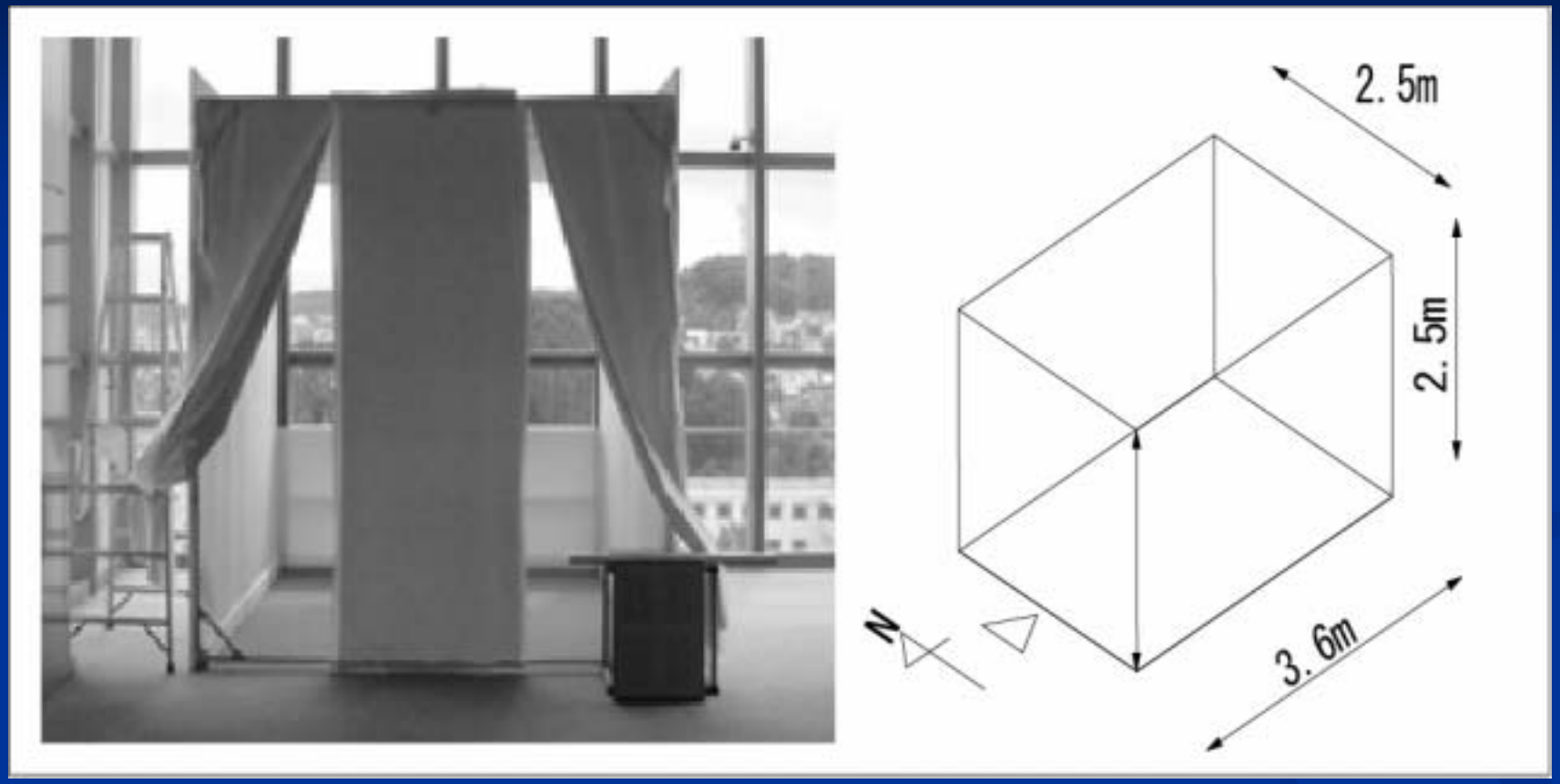


BS01. House in Okayama
Multi layer of
Policarbonate sheets
Tokyo, Japan

Results of classification

- The classification of all examples into four sections which are upper surface, vertical surface, whole surface, and lower surface.
- 80 % or more of all examples control daylight by vertical surface.
- There was no control system of daylight by lower surface of buildings.
- External louvers are 40 % versus penetrated systems such as light shelf are 10 % of the vertical surface respectively.

2. Experimentation of indoor Illuminance



A view of experimental space

Sapporo School of the Arts, July and August in 2002

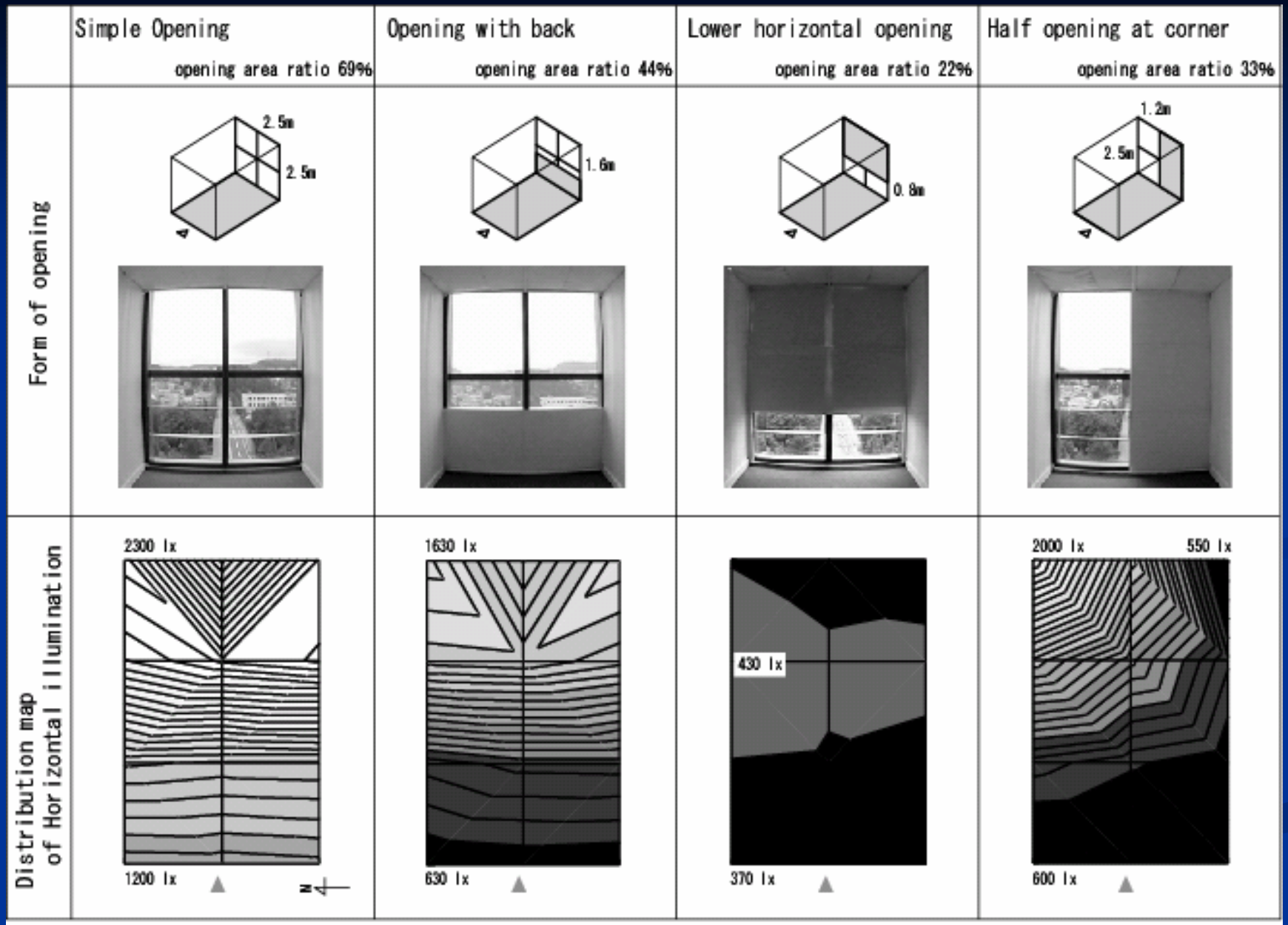
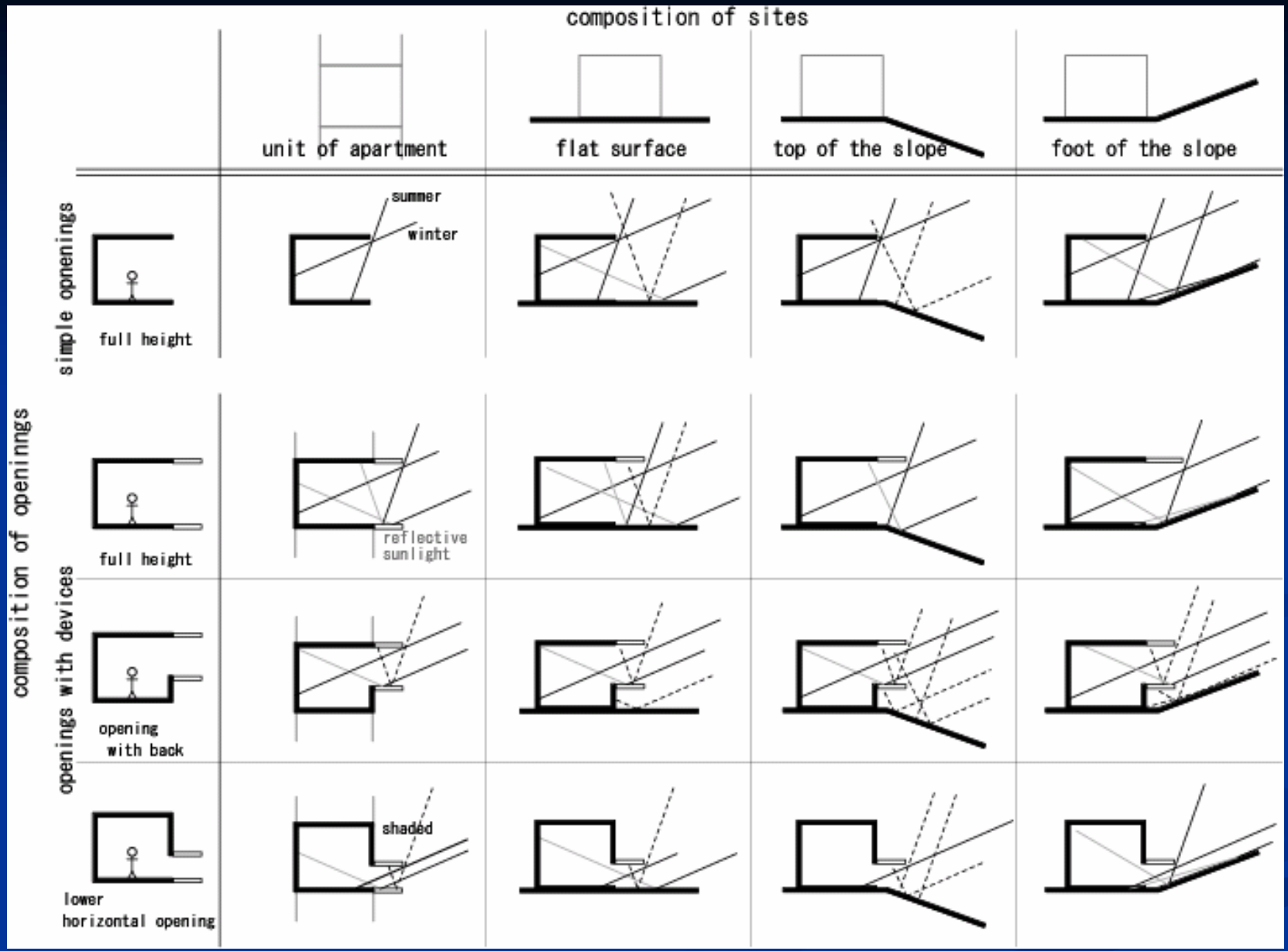


Figure 2 Distribution map of Horizontal illumination in each opening

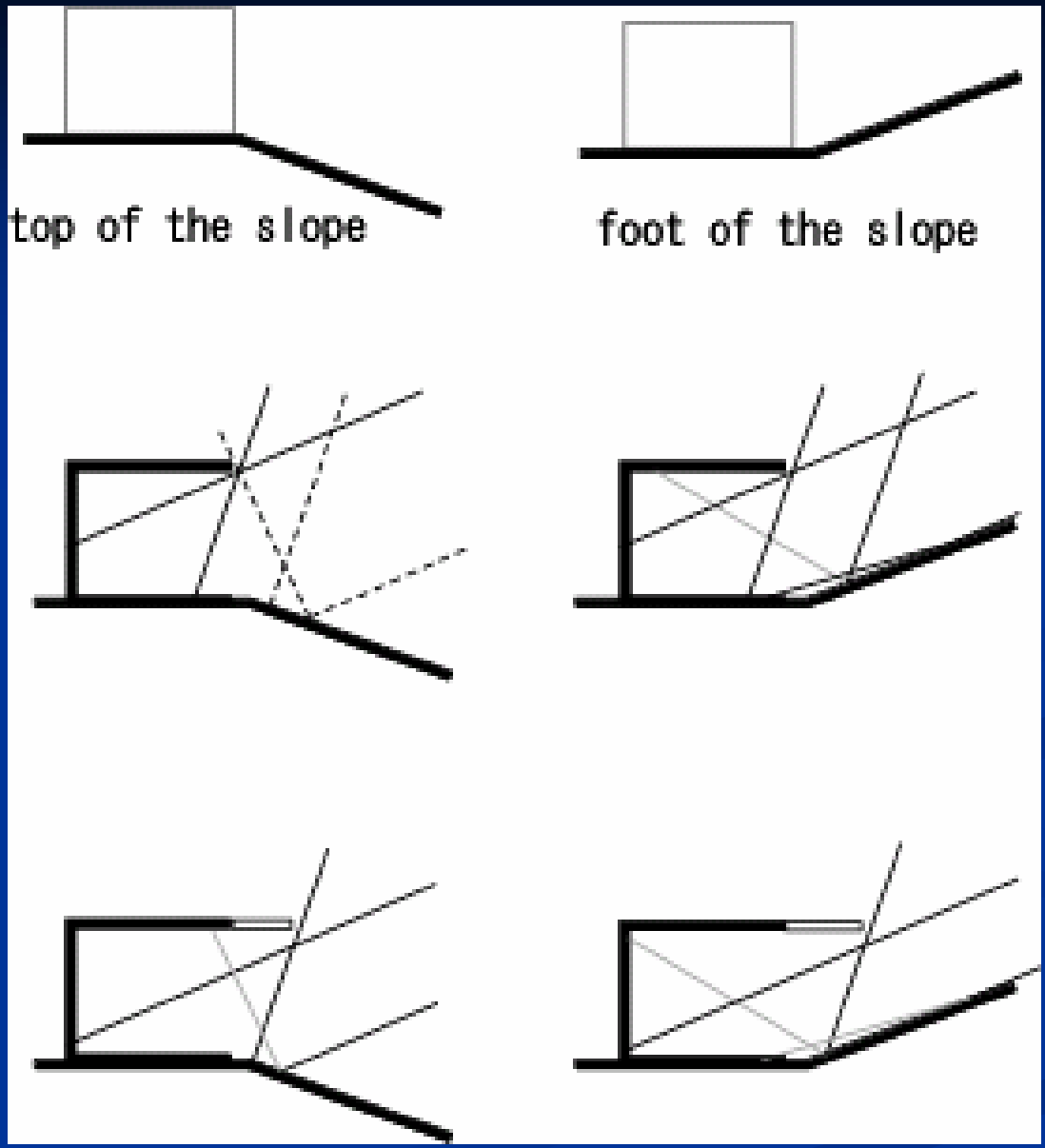
Luminous Performance of Lower Opening

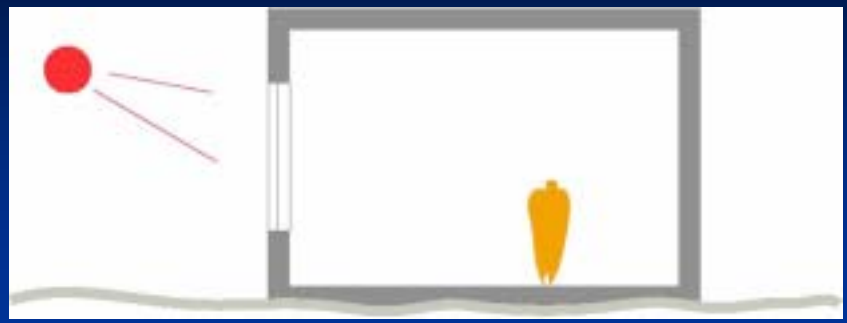
- Lower opening can take delicate shade of daylight.
- Lower opening comes into being the smallest uniformity ratio any other opening.
- In the case of lower opening the subjects could get comfortable regarding brightness sensation relatively.

3. Sectional Examples



Sectional examples of daylighting systems
with considering reflective sunlight in Sapporo (43 ° N)


top of the slope
foot of the slope



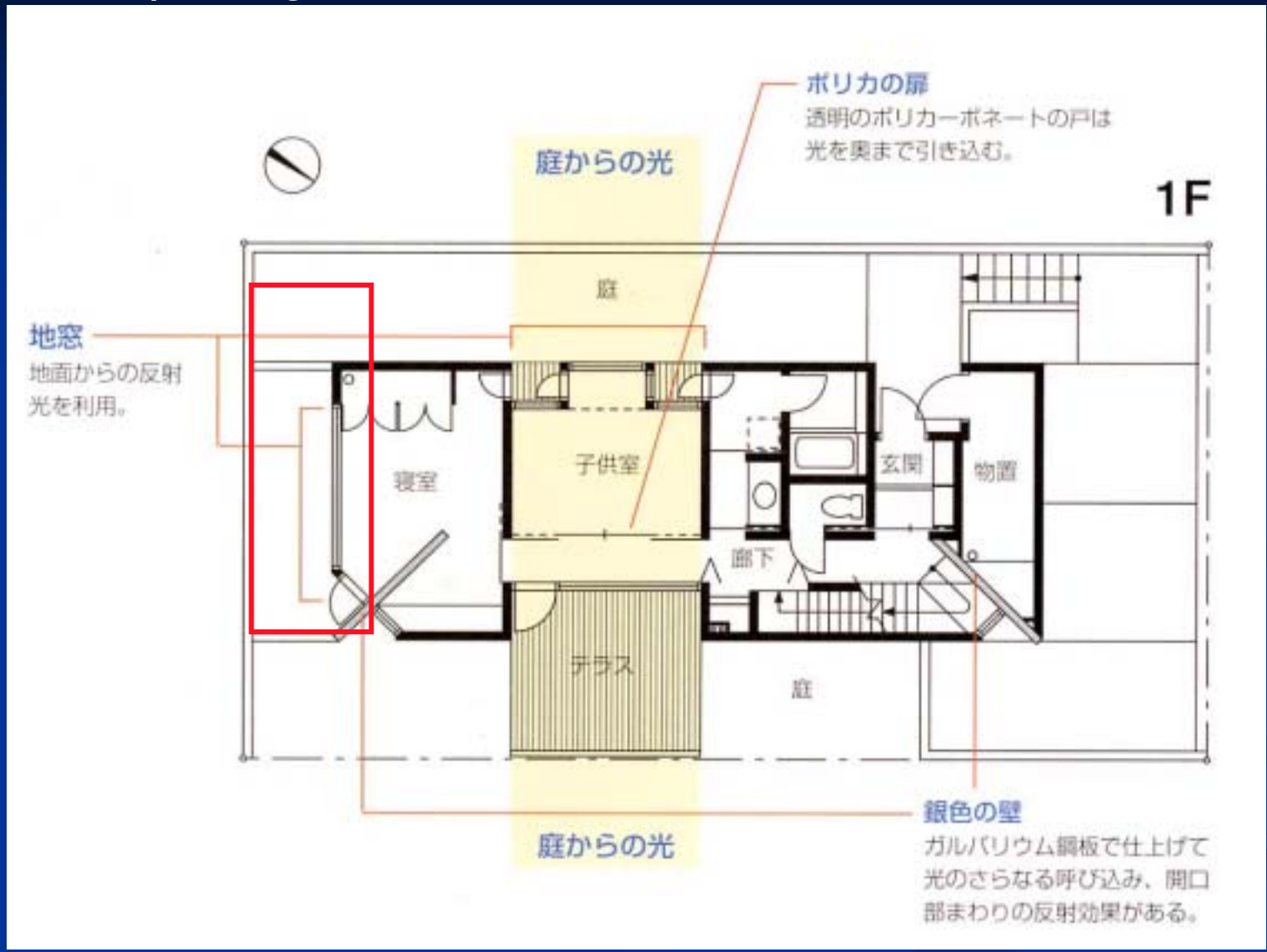
Verification by utilizing a sectional model (Saito and Suzuki, 2003)

Photo by Kouji Sakai

An example in Sapporo

Prof. Hiroshi Kawahito, Hokkaido Institute of Tech.

Lower opening



Sakaigawa-no-Ie, 2001 Sapporo

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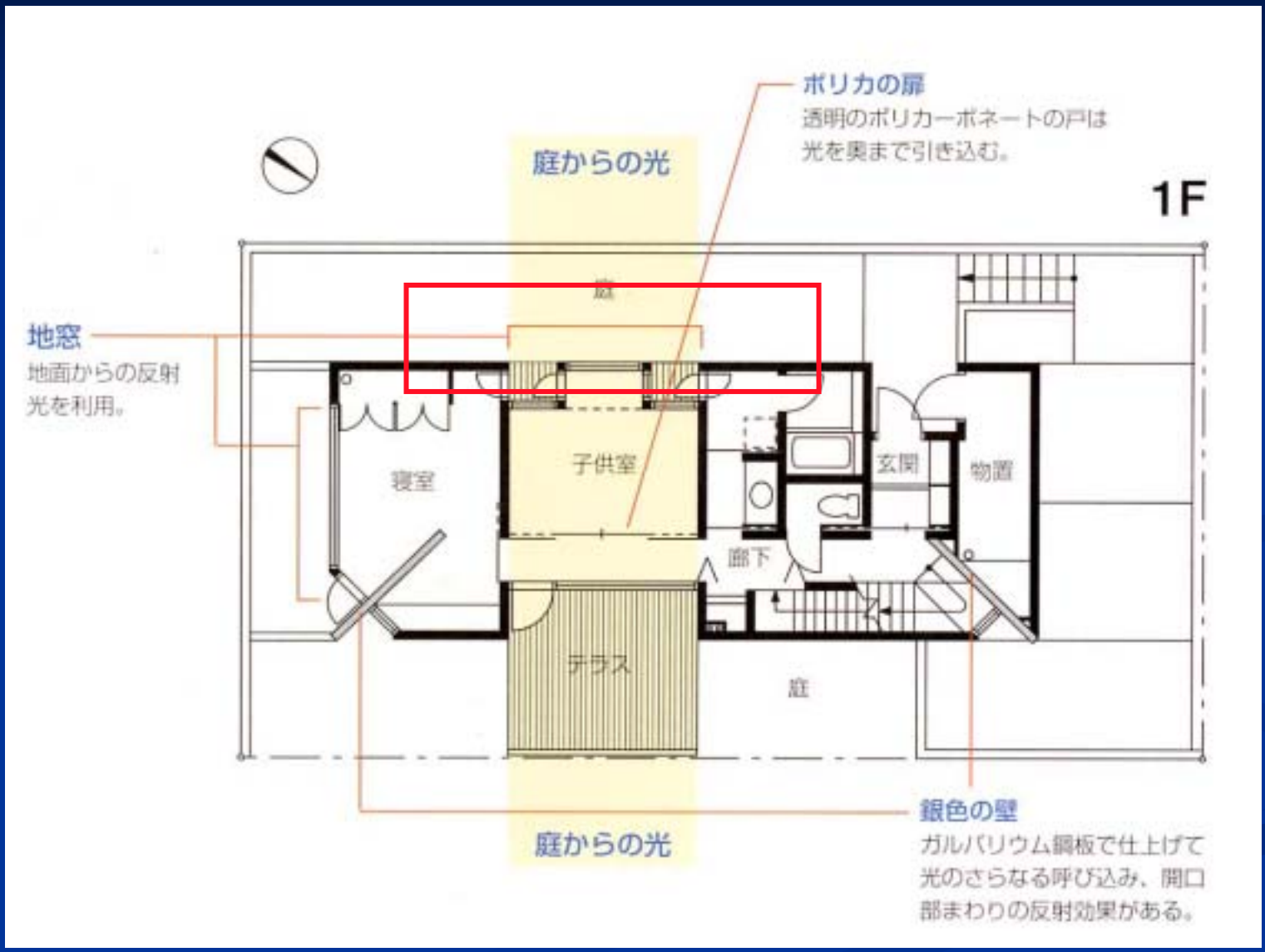
Lower opening



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Conclusions

- 80 % or more of all examples control daylight by vertical surface. There was no control system of daylight by lower surface of buildings.
- Lower opening can take delicate shade of daylight.
- Lower opening comes into being the smallest uniformity ratio any other opening.
- It would might be considered that occupants in the case of lower opening can NOT feel glare less than any other case.