Simulation and Analysis of Light Trespass of Advertising Signs on the Shophouse in Taiwan

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Introduction

- the commercial prosperity in urban areas at nighttime
- In Taiwan, according to Ding-chin Chou (2000), 29% of the residents feel affected by light pollution and 73% of those interviewed believe that the light pollution mainly comes from advertising signs, which result in serious light trespass.

Light control ordinances for signage

Limit Project	Time	Zone E1	E2	E3	E4
Illuminance on facade facing the signs (E_v)[lux]	before curfew(07:00-23:00)	2	5	**10**	**25**
	after curfew(23:00~07:00)	0	1	**2**	**5**
Maximum average luminance of sign over the entire surface of the sign (L)[cd/m^2]	-	50	400	**800**	**1000**

Environmental Zones:
E1 - *Areas with intrinsically dark landscapes*: National Parks, Areas of outstanding natural beauty
E2 - *Areas of low district brightness*: outer urban and rural residential areas
E3 - *Areas of medium district brightness*: generally urban residential areas
E4 - *Areas of high district brightness*: generally urban areas having mixed residential and commercial land use with high night-time activity.

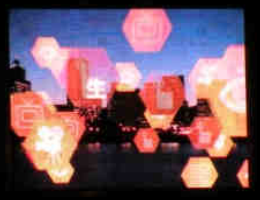
CIE, Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations (CIE, Vienna, 2003), p. 11

Categories of Advertising Signs

Externally Lighted Signs

Internally Lighted Signs

Neon tube signs



LED Display Panels

advertising signs
perpendicular to the facade

advertising signs
parallel to the facade

Advertising Signs on Shophouse

- Shophouse, a traditional kind of dwelling type most commonly seen in Asian societies, consists of shops on the ground floor and residential accommodation upstairs.
- Shophouses are typically located alongside the street, with advertising signs installed densely on the facade.
- We should discuss and analyze all of these signs comprehensively.

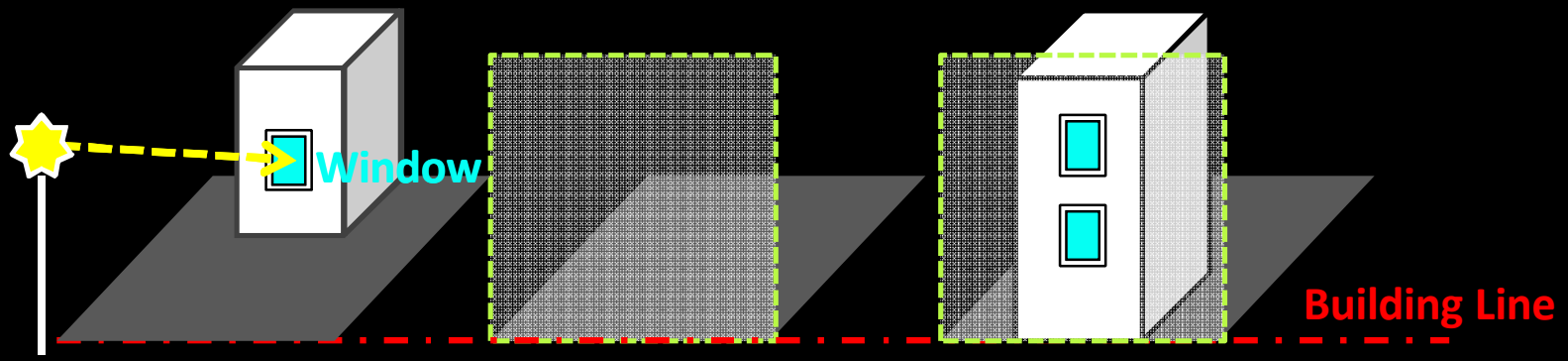
Residential

Commercial

Dwellings located in residential district (this picture comes from google map)

Light Trespass Regulation

- Vertical illuminance is often used to regulate the light trespass of outdoor light source to the interior of adjacent buildings.



- It is actually quite difficult to measure the vertical illuminance on facade by illuminance meter because the shophause is commonly in height of 4 to 6 floors.

To solve this problem

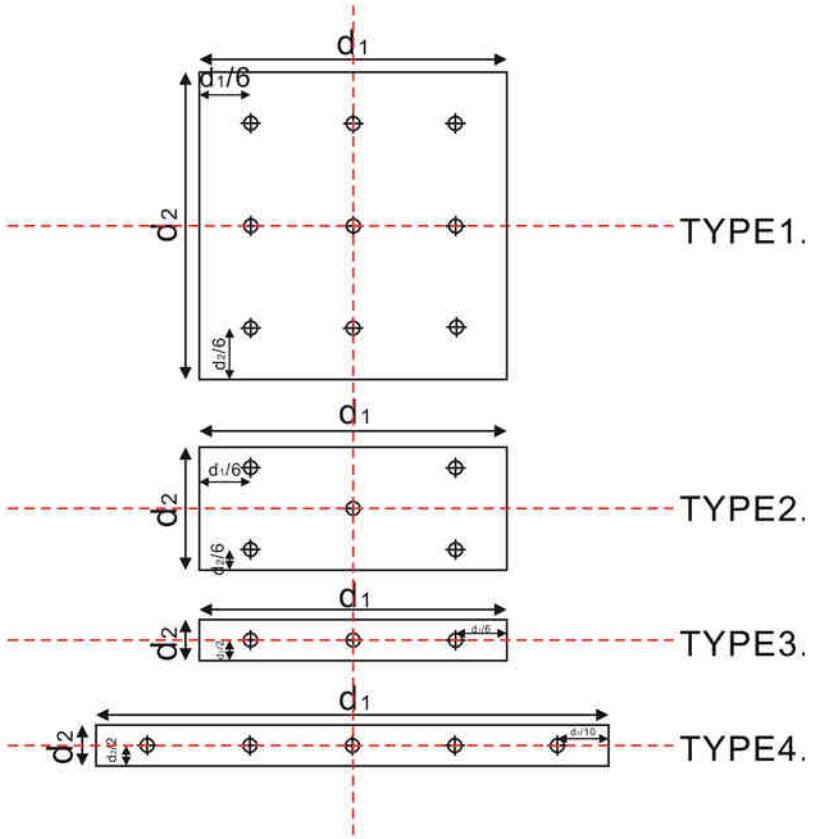
the advertising sign luminance measurement

+

simulation by lighting software

Method

- ***Luminance measurement of advertising signs***
  - luminance meter : LS-100 of Konica Minolta
  - Observers stood in front of the sign across the road, and measured its luminance in a different order, which was chosen according to the length-to-width proportion and dimension.
  - Reading scope must not be overlapped.
  - Advertising-sign luminance was calculated by the average value of all measuring points.
  - The length and width of the sign was measured to evaluate the sign coverage area.

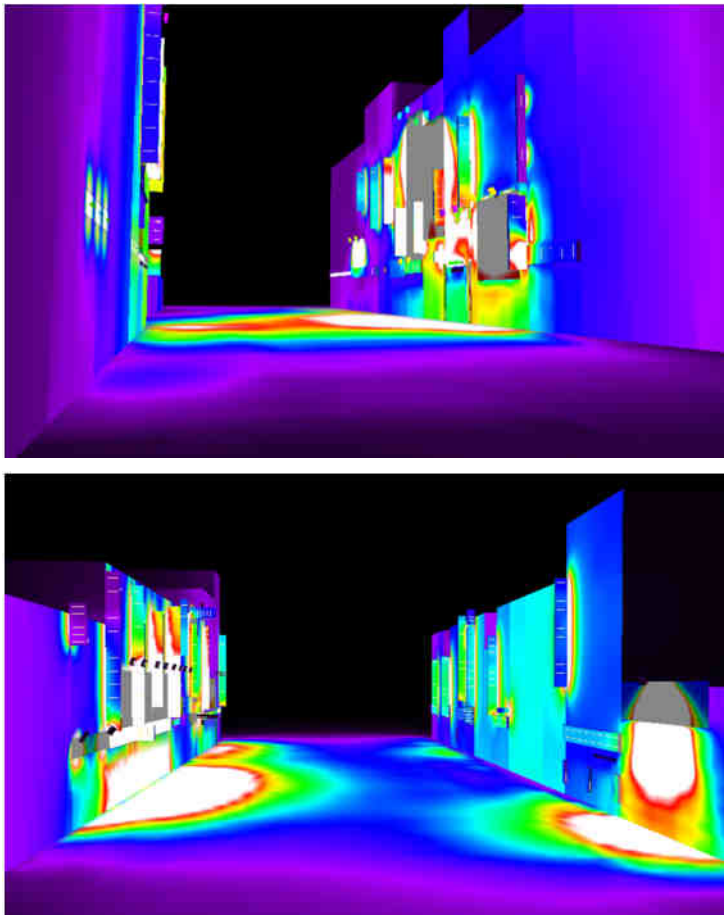


The distribution of measuring points by the length-to-width proportion and dimension of signs

Method

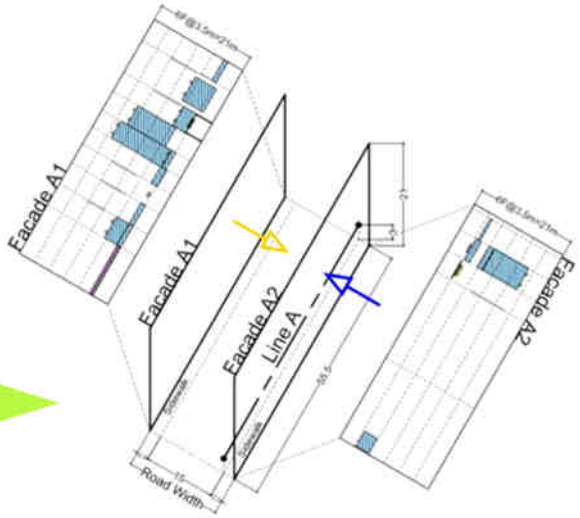
- ***Vertical illuminance simulation***

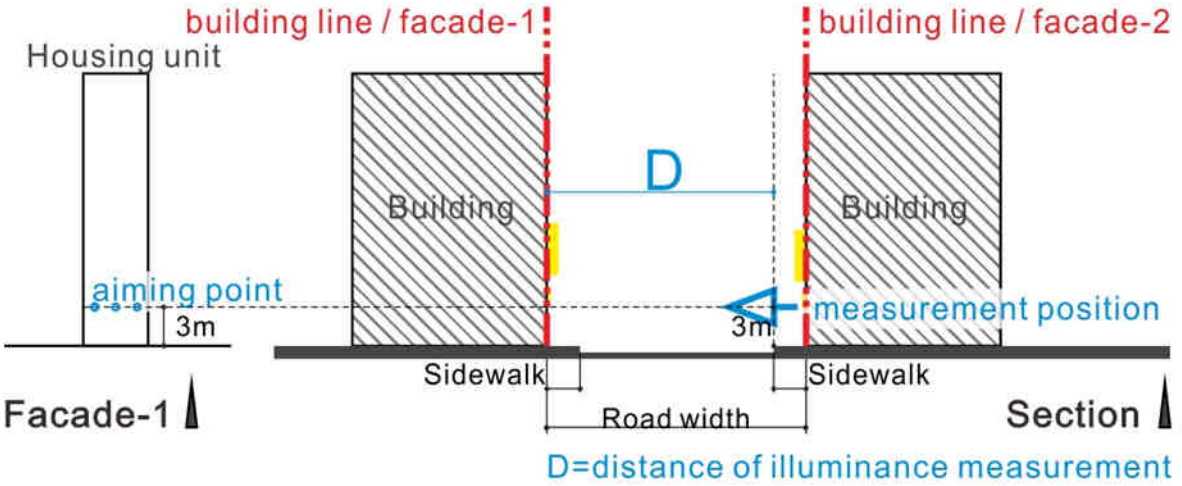
  - The lighting software : DIALux
  - GIS map / measurement of sign dimension ⇨ 3D
  - Put appropriate light source with proper light intensity into the advertising signs
  - adjust the percentage of light transmittance and reflectivity to make the luminance of the advertising sign in 3D model fit the value of measuring luminance
  - in the fourth category of residential land → 50% legal building coverage ratio and 300% legal floor area ratio → the facade on building line was hypothesized as 21-meter-high (around 6 floors with each floor 3.5m high



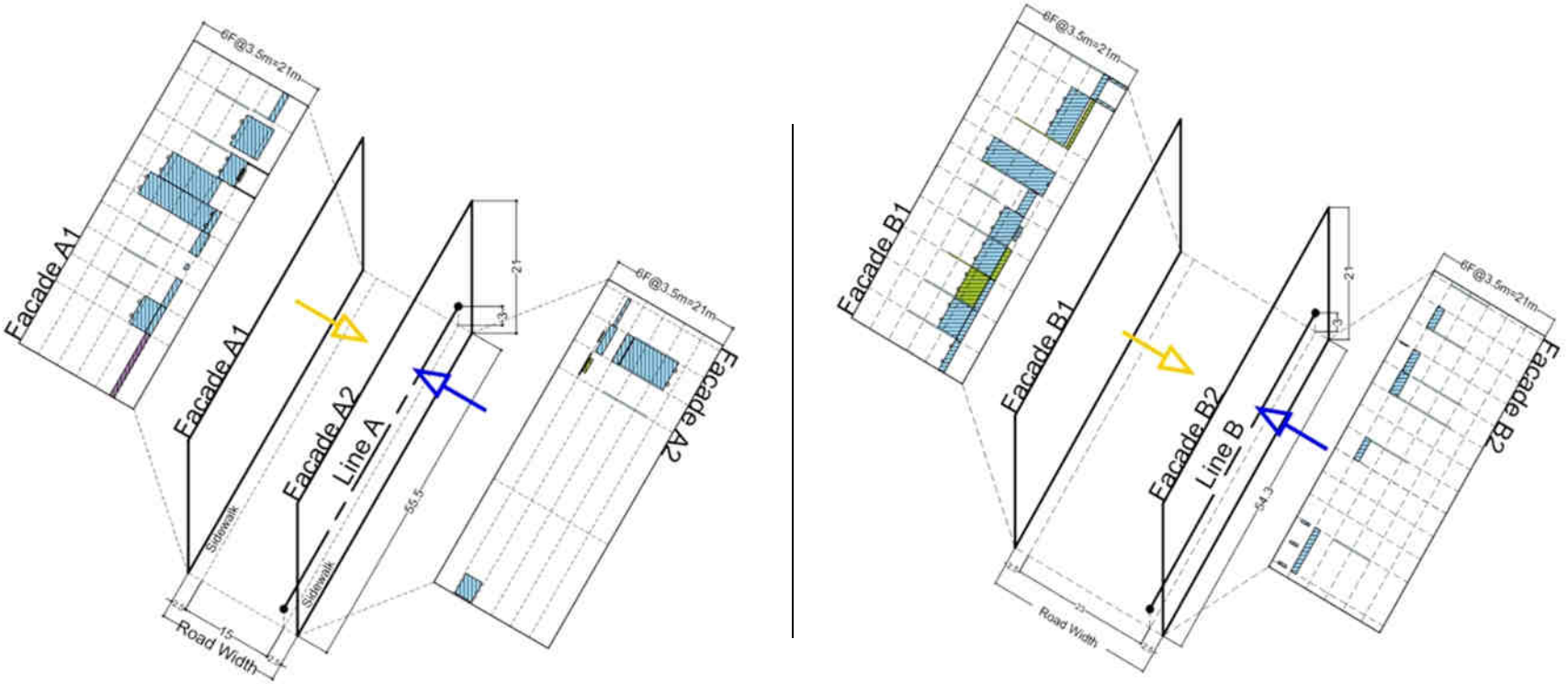
Method

- ***Vertical illuminance measurement***
  - Vertical illuminace of 3 meters high was still measured by illuminance meter, Minolta T10, to prove if the simulation results are accurate.
  - Vertical illuminance was measured along the border of the side walk.
  - Three points (as the aiming points shown below) per housing unit were measured.
  - The vertical illuminance was measured at two timings: evening and night.
  - The effect of streetlamps on vertical illuminance can be removed by subtracting the measuring illuminance in the late night(signs are closed) from that in the evening(signs are lighted).





Result



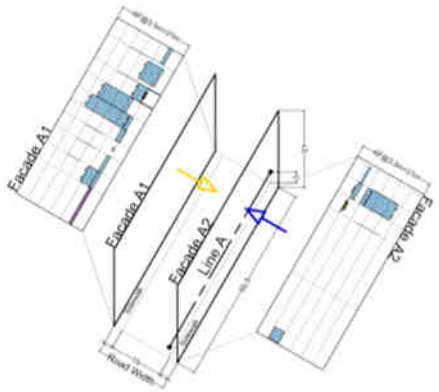
Street A-20m **Street B-28m**

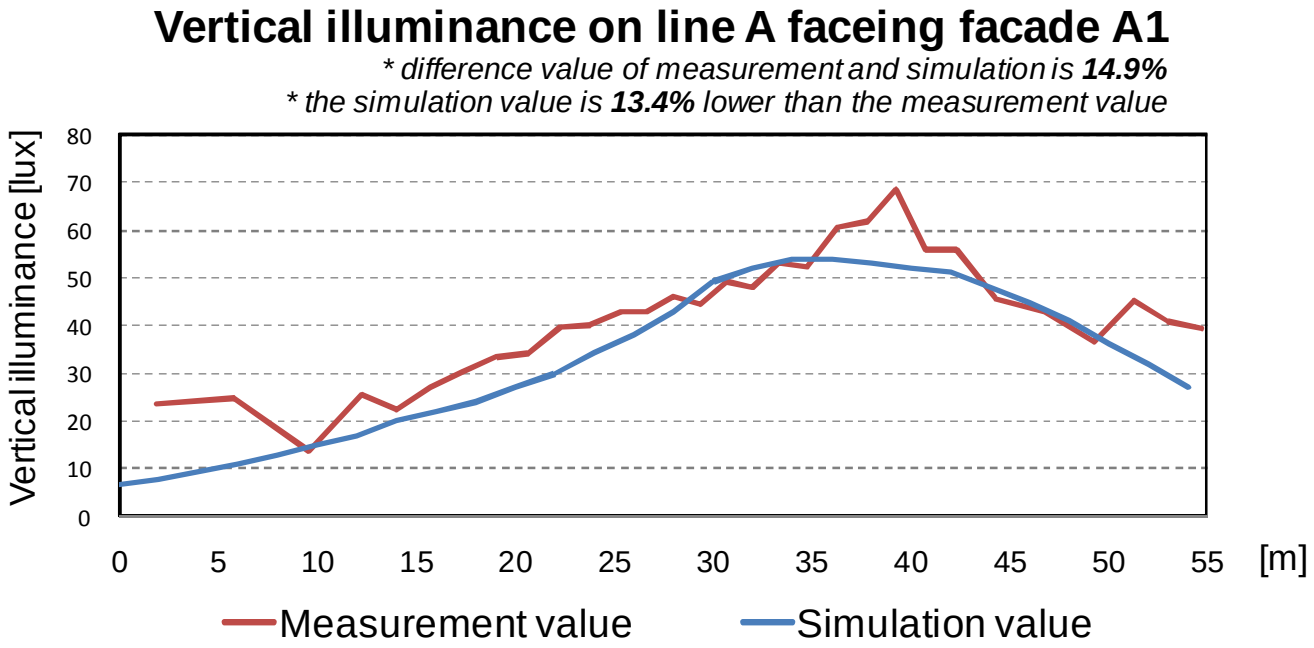
- <200 [cd/m²]
- 200-400 [cd/m²]
- 400-600 [cd/m²]
- 600-800 [cd/m²]
- 800-1000 [cd/m²]
- >1000 [cd/m²]

- advertising signs parallel to the facade
- advertising signs perpendicular to the facade
- light direction
- View direction

Result

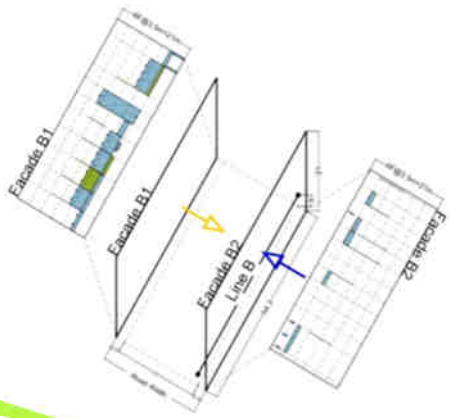
- ***Comparison between simulation and measurement value of vertical illuminance***
  - the average difference values of vertical illuminance of simulation and measurement on 20m- and 28m-street samples are 14.9% and 14.0% of measurement values, respectively.

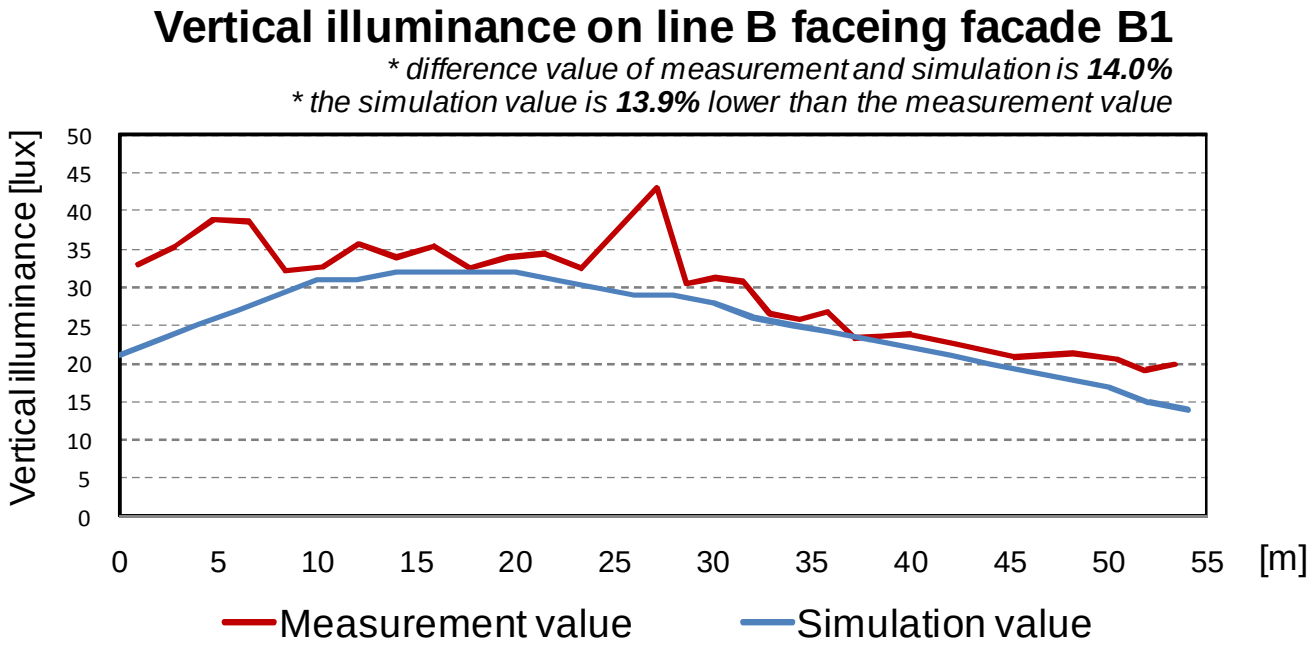




Result

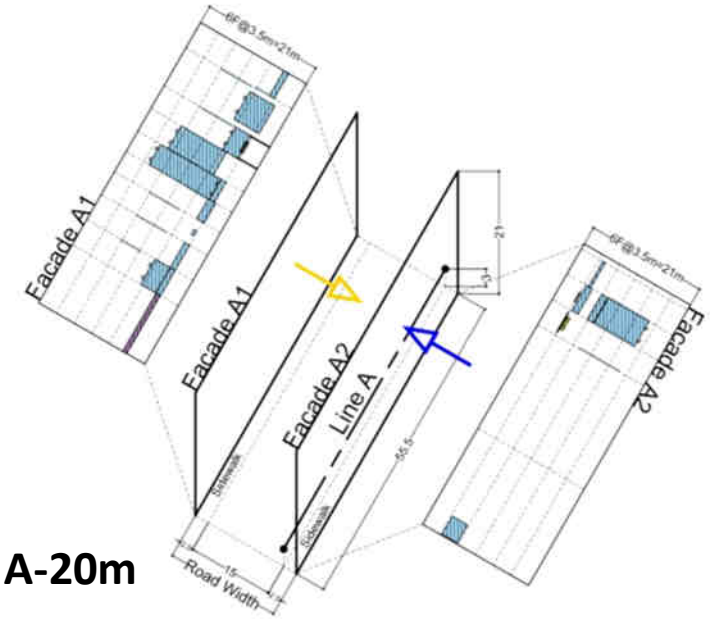
- ***Comparison between simulation and measurement value of vertical illuminance***
  - Since normally 10% to 20% of error is being expected in illuminance measurement, the results of simulation in this research could be accepted.



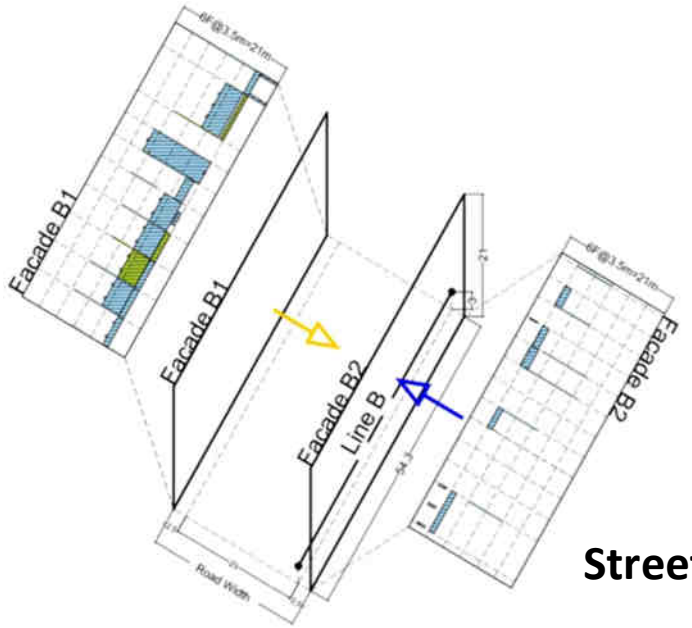


Result

- The average luminance of the advertising signs on Street A and Street B is 160 and 143[cd/m^2], respectively.
- Luminance of the advertising signs of both samples is much lower than the limit of CIE (800cd/m^2) for residential area.



Street A-20m



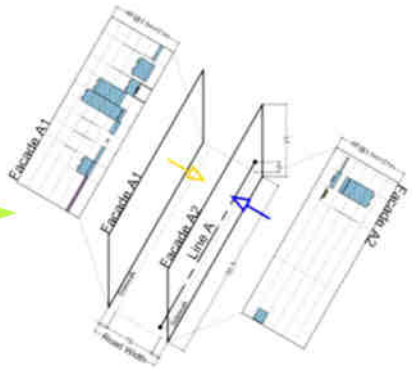
Street B-28m

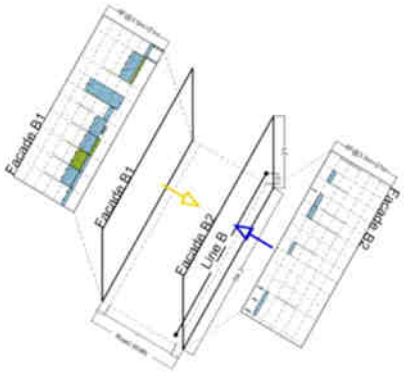
Result

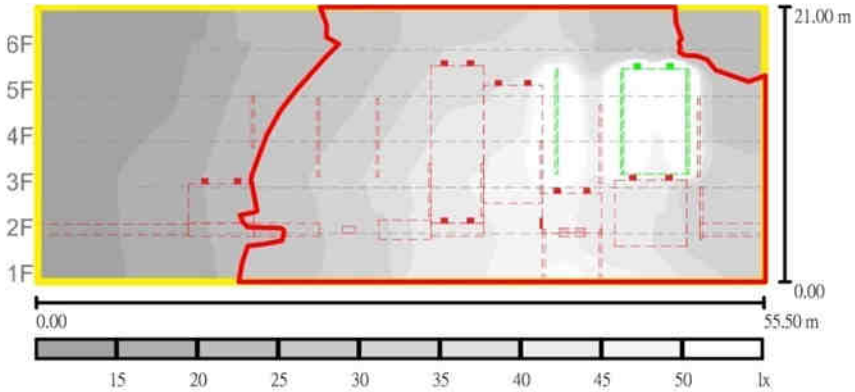
- ***Light trespass of advertising signs on the shophouse***

- *The red dashed line shows the orthogonal projection of signs on facade A1 and B1.*
- *The green line shows the signs perpendicular to the facade and those externally lighted on facade A2 and B2.*

		Facade	
		A2	*B2*
Area which exceeds the limit of vertical illuminance by CIE for commercial area before curfew, 25lux	☐	*64%*	*39%*
Area which exceeds the limit of vertical illuminance by CIE for residential area before curfew, 10lux	☐	*100%*	*100%*

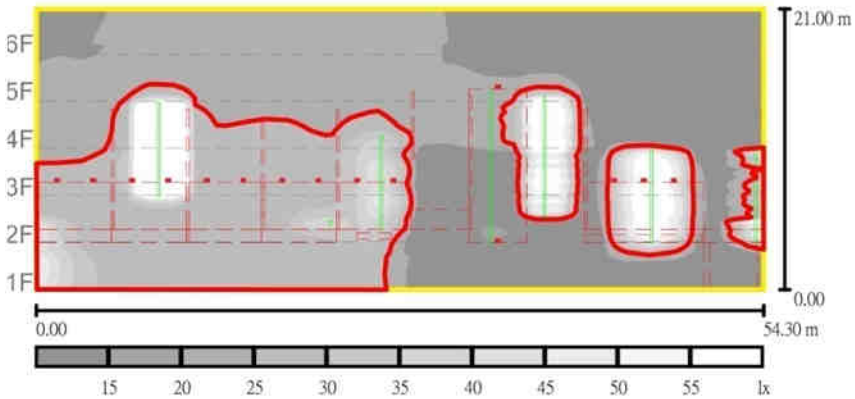






Vertical illuminance(E) distribution on facade A2

$E_{Avg.}$=34 [lux] $E_{Min.}$=12 [lux] $E_{Max.}$=574 [lux]

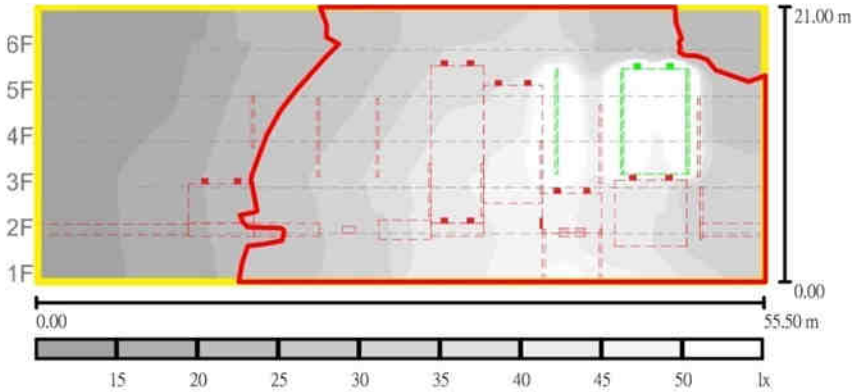


Vertical illuminance(E) distribution on facade B2

$E_{Avg.}$=26 [lux] $E_{Min.}$=12 [lux] $E_{Max.}$=154 [lux]

Result

- ***Light trespass of advertising signs on the shophouse***
  - the advertising signs installed on the facade opposite the vertical-illuminance-simulation facade are outlined on the vertical-illuminance-simulation facade by the red dashed lines.
  - The vertical illuminance on facade mainly comes from the advertising signs parallel to the facade across the street and is determined by the luminance, the coverage area and the density of those advertising signs.



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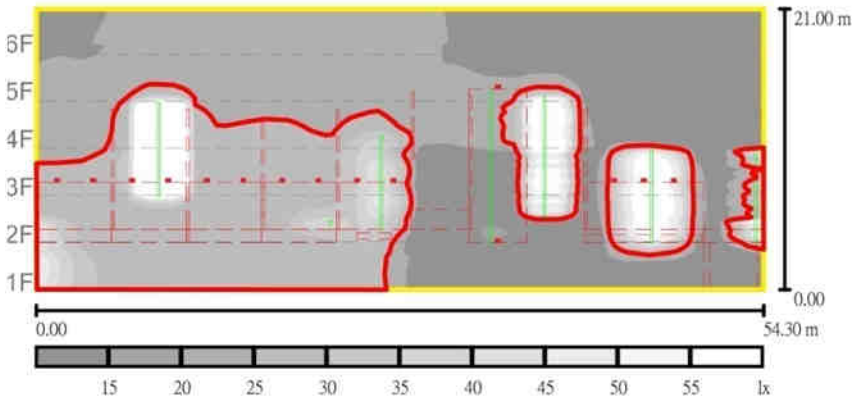

Vertical illuminance(E) distribution on facade B2

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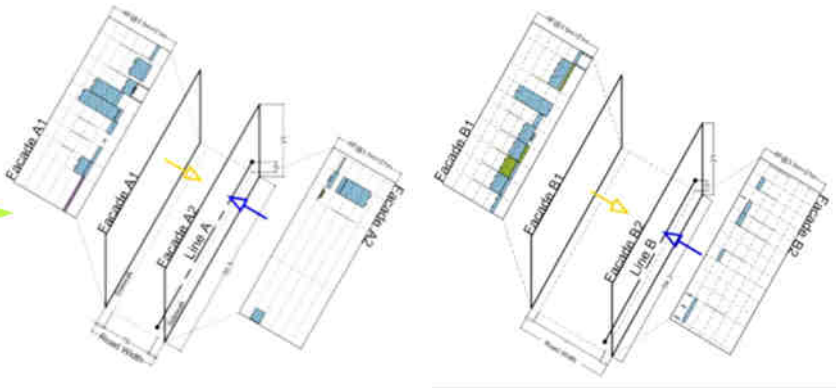
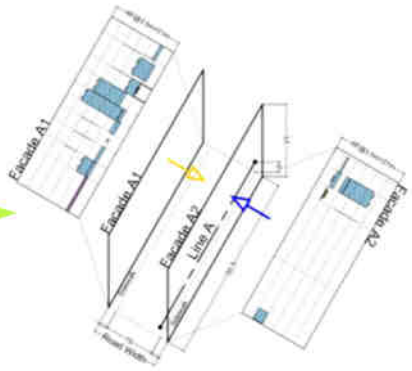
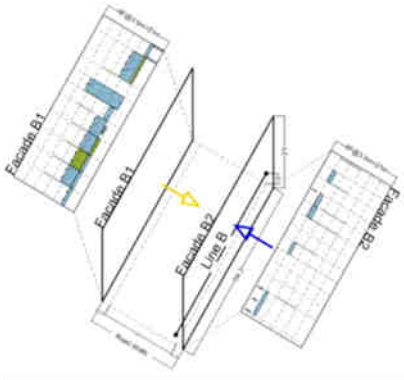
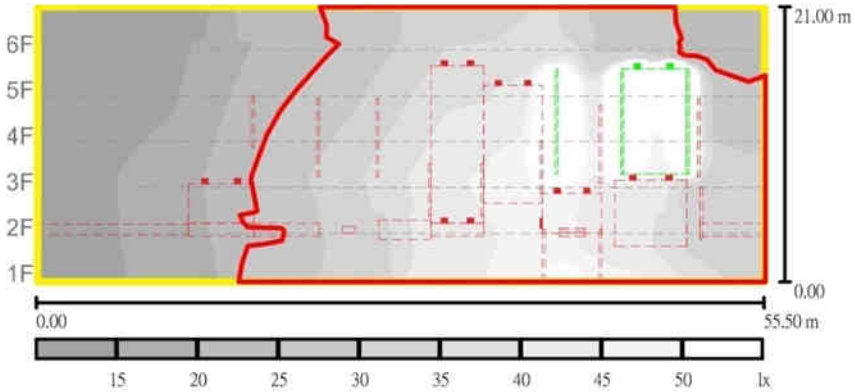


Result

- ***Light trespass of advertising signs on the shophouse***
  - The advertising signs perpendicular to the facade and externally lighted signs (illustrated by green lines) also result in considerable vertical illuminance and light trespass to the adjacent area of the facade on which they are located due to the lack of buffer distance to its adjoining facade.
  - Thus, these signs should not be installed on residential floors.







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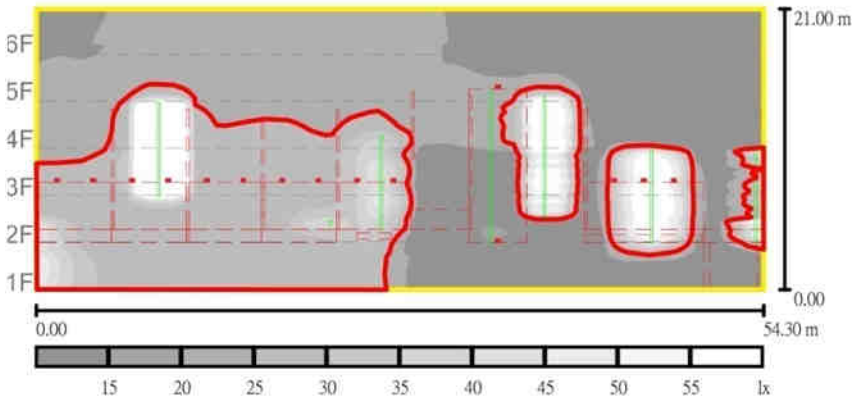

Vertical illuminance(E) distribution on facade B2

$E_{Avg.}$=26 [lux] $E_{Min.}$=12 [lux] $E_{Max.}$=154 [lux]

Conclusion

- In brief, in order to effectively control the light trespass, this research suggests that not only the luminance but also the coverage area, the density, and the installed position of the advertising signs be taken into consideration and further regulated.

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Thanks for your attention