Daylight availability, building orientations and ground factors in urban areas: a case in Sweden

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ABSTRACT

Daylight availability is a crucial environmental indicator of sustainable urban areas, especially in terms of human well being, health and energy savings. This study analysed the impact of building orientations and ground surface reflectances on the potential of indoor daylight utilization in the Swedish urban context.

Two fundamental building layouts in Swedish cities were investigated: linear model and square model. For the ground between buildings, six various surface reflectances have also been studied, which could represent the typical photometric properties of the ground materials found in the Swedish cities. DAYSIM, a CBDM package, was adopted to simulate the annual profile of vertical illuminance at the façades. It has been found that under Swedish climate conditions, orientations take little effect on the daylight availability of the bottom facades, especially during the heating seasons (Nov 1 – March 31). The increasing ground surface reflectances significantly increase the vertical daylight levels at the studied façade position.
INTRODUCTION

- Daylight (skylight and sunlight) – energy saving, **human well being and health**

- Daylight availability in urban scale – critical environmental factor in a sustainable city help to define daylighting utilization in buildings

METHODOLOGY

Models of urban layout

- Linear Model
- Square Model (court)
METHODOLOGY

Studied positions at building facades

Ground materials and reflectances

Typical photometric properties of the ground materials found in the Swedish cities:

- 0.2 (a common ground reflectance);
- 0.07 (soil);
- 0.3 (grass);
- 0.4 (concrete);
- 0.55 (old snow);
- 0.8 (fresh snow).
**METHODOLOGY**

Daylighting simulations

1. Daylight illuminance (lx) – vertical surface of facades

2. Climate-based daylight modelling (CBDM)

3. Swedish climate condition (Stockholm)

4. Calculation engine --- Daysim (Radiance + Daylight Coefficient)
   Weather data --- step (1 hour)

5. Period (Nov 1 --- Feb 28) heating season

**RESULT AND DISCUSSION**

Daylight availability of south and north facade

![Graph showing daylight availability of south and north facade](graph.png)

- South Facing
- North Facing
RESULT AND DISCUSSION

**Linear model**

*Available illuminance and reflectance*

- **North facade**
- **South facade**

*Surface Reflectance of Facade*

*Average vertical illuminance (Lx)*

- 0,07
- 0,2
- 0,3
- 0,4
- 0,55
- 0,8

*Percentage difference of average illuminance (%)*

- -20%
- -10%
- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%

*Surface Reflectance of Facade*
RESULT AND DISCUSSION

Square model

Available illuminance and reflectance

Average vertical illuminance (lx)

Surface Reflectance of Facade

North facade
South facade
East facade
West facade

40lx

RESULT AND DISCUSSION

Square model

Percentage difference of average illuminance (%)

Surface Reflectance of Facade

North facade
South facade
East facade
West facade
CONCLUSIONS

(1) The configurations of ground landscape of could be regarded as a crucial factor which influences the daylight availability in Swedish urban areas;

(2) It is necessary to analyze the daylight availability in terms of various seasons under Swedish climate conditions; Heating season could be considered separately;

(3) It is quite possible that an environment with snow increases the daylight levels on facades, especially for the ground floor;

(4) Facing south could be still a key passive design strategy according to daylighting. For court layout, north, east and west façade receive similar daylight levels which are relatively lower than the south façade;

(5) Limitation: more deep analysis could be required to achieve a reasonable daylighting assessment, e.g. summer; a new daylight metric is strongly needed to evaluate the daylight availability in urban areas.

THANKS A LOT FOR YOUR ATTENTION!

ANY QUESTIONS?