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.

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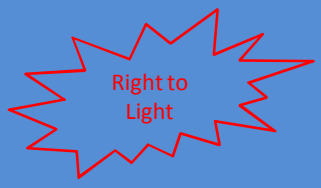
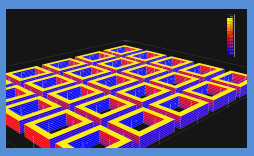
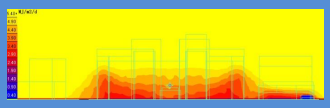
INTRODUCTION

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



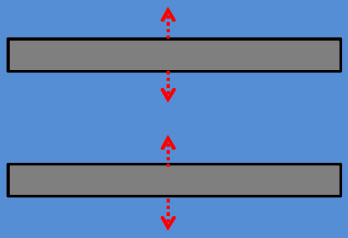
❑Daylight availability in urban scale – critical environmental factor in a sustainable city
help to define daylighting utilization in buildings



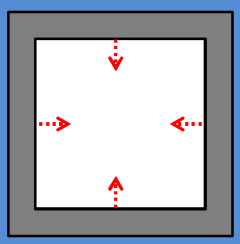


METHDOLOGY

Models of urban layout



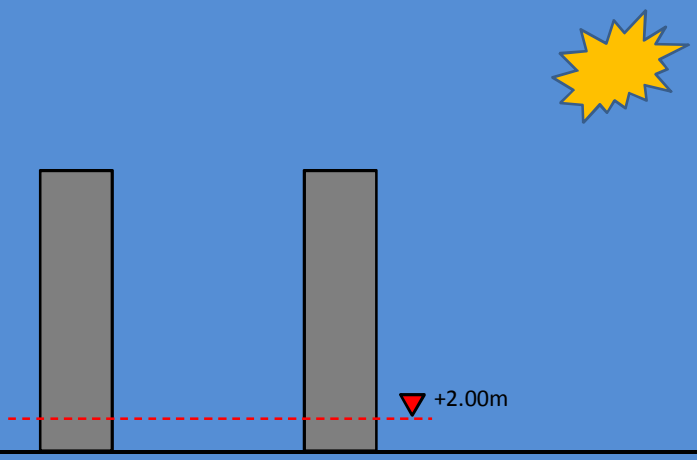
Linear Model



Square Model
(court)

METHDOLOGY

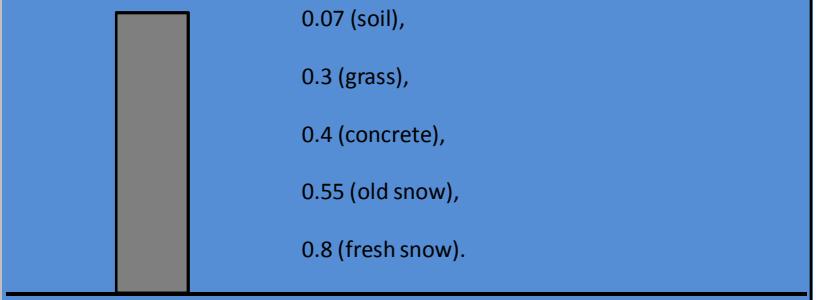
Studied positions at building facades



METHDOLOGY

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).

METHDOLOGY

Daylighting simulations

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

2.Climate-based daylight modelling (CBDM)

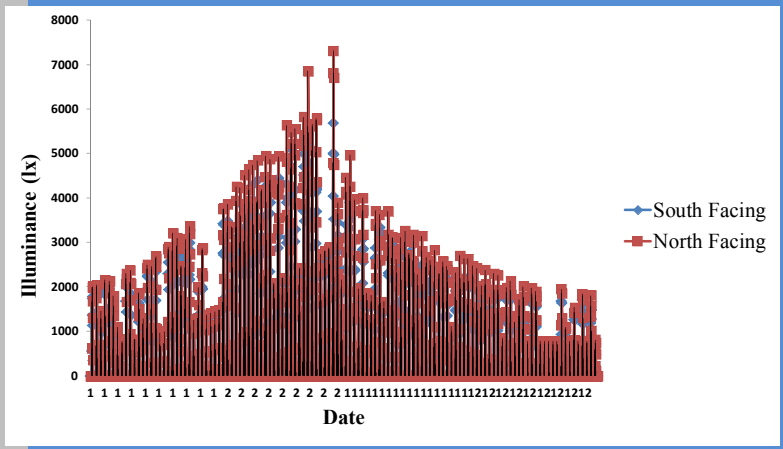
3.Swedish climate condition (Stockholm)

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

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

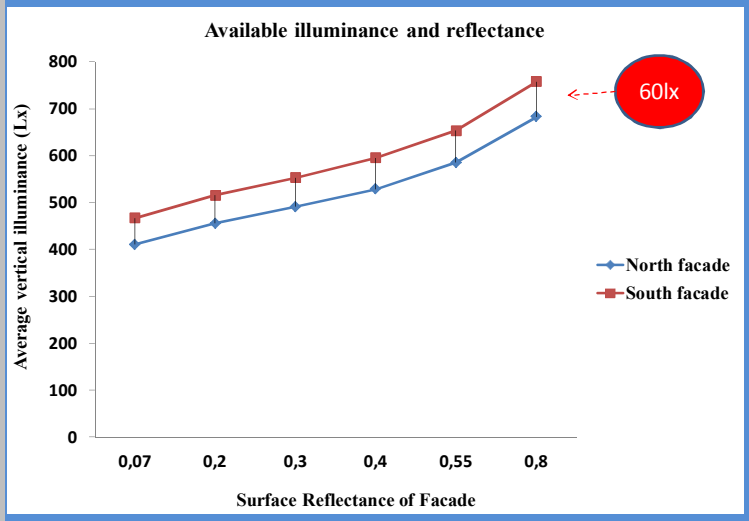
RESULT AND DISCUSSION

Daylight availability of south and north facade



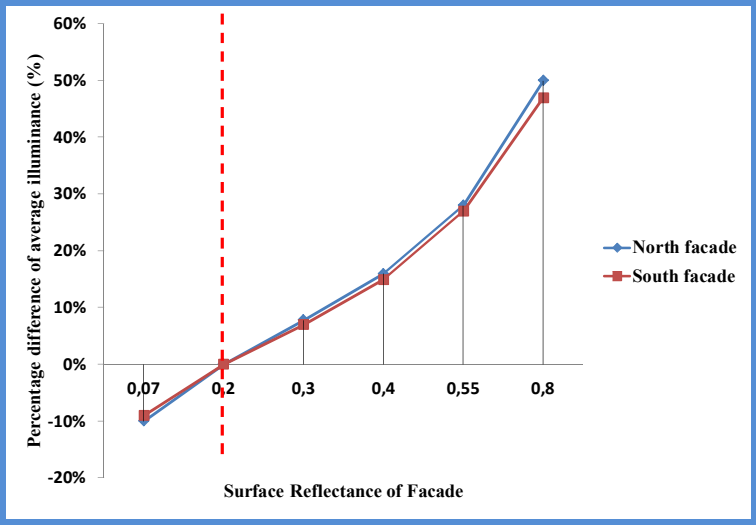
RESULT AND DISCUSSION

Linear model



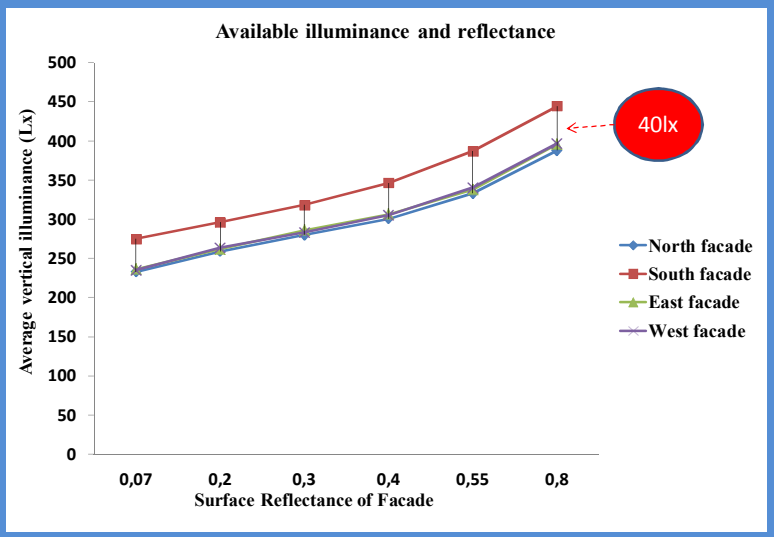
RESULT AND DISCUSSION

Linear model



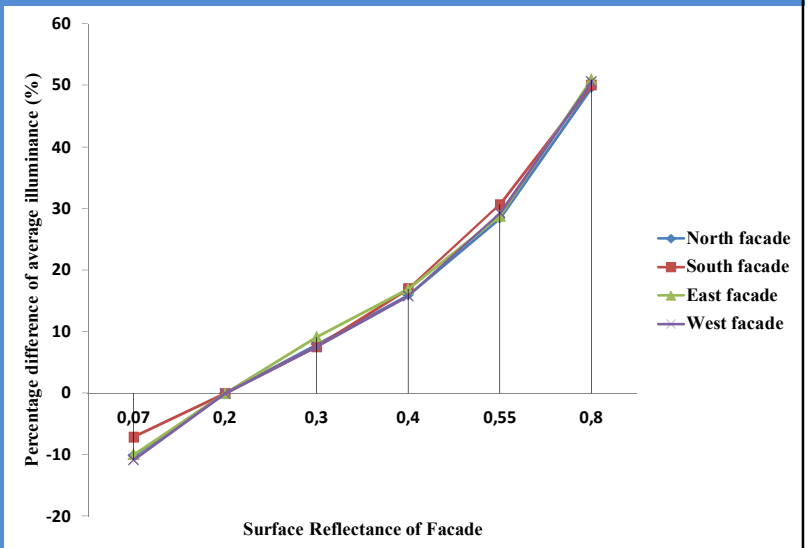
RESULT AND DISCUSSION

Square model



RESULT AND DISCUSSION

Square model



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 facade.;

(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?