Risk of poor daylight in new and retrofitted buildings in Norway

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Introduction

Political authorities in Norway have pointed out the way towards nearly-zero-energy buildings in 2020 with passive house standard as building regulation requirement from 2015. Also with respect to retrofitting, strict energy requirements will be set. However, the reduction in energy use should not decrease the quality of indoor environment.

Yet, some times it may seems like good daylight conditions are disregarded in modern building design, even though satisfying daylight conditions are important with respect to user comfort and health [1-3]. Both new and retrofitted buildings usually end up with thick and well insulated walls to reduce the heat loss and windows with low g-value and low light transmission to reduce the cooling demand. These physical properties leads to significant reduction of daylight penetration to the room. However, a number of the methods used at the present time to document satisfying daylight conditions by Norwegian building designers do not take these building trends into consideration. It is therefore suspected that use of these methods might lead to design of gloomy buildings.

The Norwegian building regulations (TEK10) require that buildings shall have satisfying daylight supply without inconvenient heat gains. In order to meet this requirement, the guidance to TEK10 gives two pre-accepted performance targets:

1. Confirm that the average daylight factor ($\overline{DF}$) in the room is minimum 2 %.
2. Document that the daylight pane of the room constitute at least 10 % of the used floor area, where the daylight pane is the total unshaded glazed area that transmit daylight to the room.

Different methods exist to confirm a $\overline{DF}$ ≥ 2% and acknowledged methods in the building sector in Norway are e.g. use of diagrams developed by SINTEF Building and Infrastructure [4] or use of computer simulations. The diagrams from SINTEF Building and Infrastructure gives the correlation between glazed area/used floor area and $\overline{DF}$.

Method

A case study is analysed to see if the diagrams from SINTEF Building and Infrastructure and the 10 % rule are suitable methods to use to ensure sufficient daylight conditions in energy effective buildings. The methods are tested against simulations performed with Daysim.

The test-case is based on a typical cell office with massive insulation in the walls and energy effective windows. A visualization of the model is given in Figure 1 and the calculation assumptions are given in Table 1.

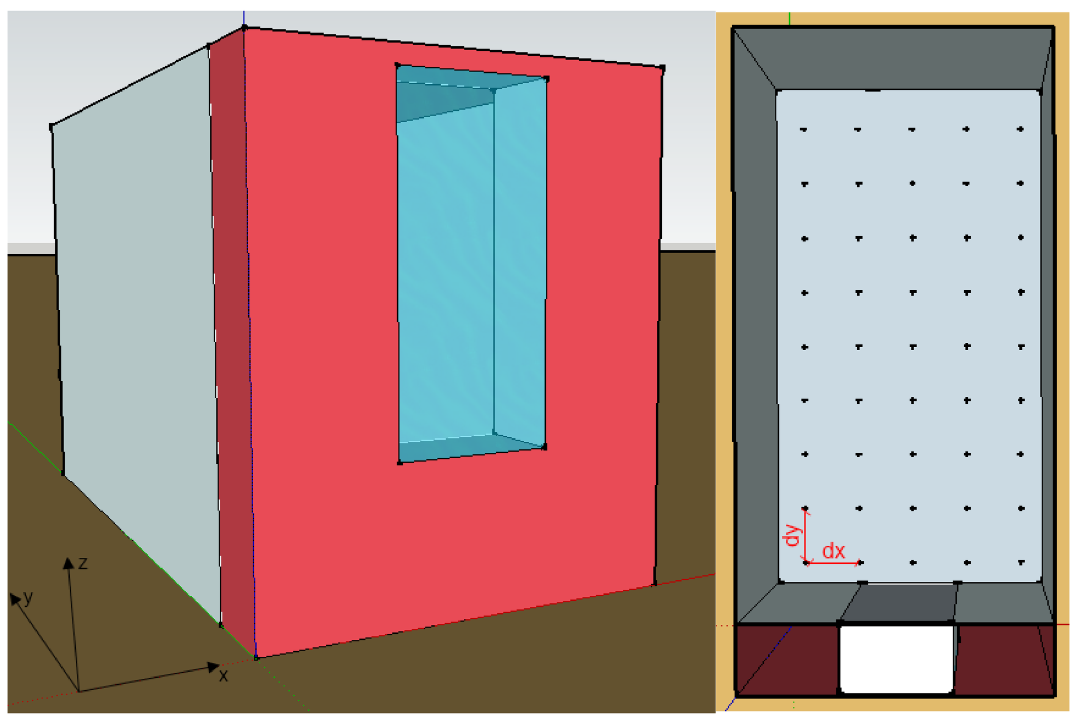

Figure 1: Left hand side: visualisation of the test-case model in Google SketchUp. Right hand side sensor points for daylight factor calculation in height 0.8m above floor level. dx=dy=0.45m.

Table 1: Calculation assumptions for the test-case

Room width		2.2	[m]
Room depth		4.1	[m]
Room height		2.7	[m]
Wall tickness		0.5	[m]
Window height		1.8	[m]
Window width		0.8	[m]
Glazed area / used floor area		16	[%]
Parapet		0.8	[m]
Light transmittance glazing		50	[%]
Reflectance	Wall	50	[%]
	Ceiling	70	[%]
	Floor	20	[%]

Results

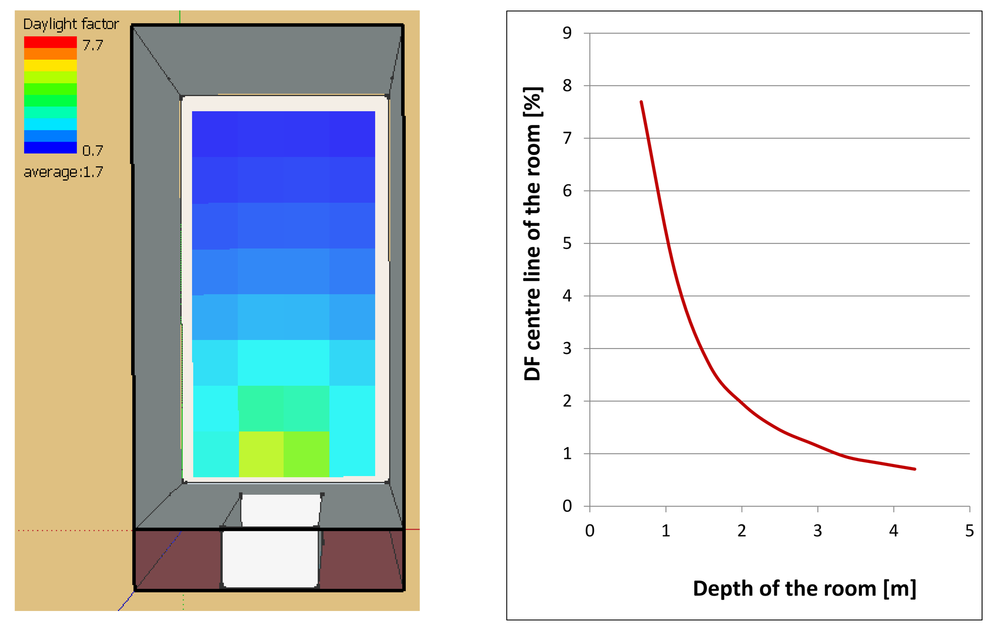

Figure 2: Visualisation of the results from Daysim, variation of the DF in the room and illustration of how the daylight factor decrease with the depth of the room x=1,125.

Table 2: Evaluation of the daylight conditions in the test case according to how the methods are presented in guidance to Norwegian building codes.

Method	Daylight conditions	Comment
10 % rule		Glazed area / used floor area = 16 %. The daylight condition is according to this method satisfying.
Diagram from SINTEF Building and Infrastructure		This method require a correction of the light transmittance with respect to a light transmittance of 80 %. Resulting $\overline{DF}$ = 2.7%.
Daysim		Resulting $\overline{DF}$= 1.7%.

In the Danish building guidance SBi 219 [5] correction factors to use on *DF* are given for thick walls. By multiplying correction factor for this case (0.55) to the resulting *DF* from SINTEF Building and Infrastructure a resulting $\overline{DF}$=1.5 % is achieved. This leads to unsatisfying conditions according to the target of *DF* ≥ 2% and this result is in better agreement with the results from Daysim.

Discussion and conclusion

By using some of the well established methods to ensure satisfying daylight on new or retrofitted buildings without correcting for wall thickness and light transmission, one may be in danger of designing buildings with poor daylight conditions. The results from this study indicate that correction factors similar to those given in SBi guidance 219 might be suitable to use in combination with the diagrams from SINTEF Building and Infrastructure in order to predict more realistic results of $\overline{DF}$. Concerning the 10 % rule, correction factors both for wall thickness and light transmission need to be developed if this method should be usable in the future. The need for considering thick walls and low light transmittance should be explicitly stated in the guidance to the building regulation.

Several researchers have discussed the limitations correlated to use of DF as daylight metric [6, 7] and one thing seems certain; the time of the DF as the dominant evaluation metric for horizontal illumiance has passed. In the future climate-based metric should be used. Improved daylight thresholds for the guidance to the Norwegian building code should probably be based on climate-based metrics.

Further research

- Develop a methodology of how daylight should be implemented as a part of an integrated design together with thermal comfort and energy use to ensure a consistent design.
- Propose improved thresholds for daylight which secure satisfying daylight conditions.

References

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