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- Daylight / electric lighting
- Daylight basics
- Daylight factor
- Reliability / accuracy of simulation
- Daylighting strategies / glazing systems
- Climate-based daylight modelling
- Electric lighting
- Case studies

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CIBSE Application Manual AM11 ‘Building Performance Modelling’
Chapter 7: Lighting Modelling

Section 7.1
Daylight Basics

- Actual and modelled daylight
- Daylight and building occupants
- Daylight and sky conditions
- Daylight factor definition
- DF and guidelines
Section 7.1
Daylight factor definition

\[ L_\zeta = \frac{L_z (1 + 2 \cos \zeta)}{3} \]

\[ DF = \frac{E_{in}}{E_{out}} \times 100\% \]
Section 7.2
Methods to predict the daylight factor

• ‘Historical’
• Rules of thumb
• Average daylight factor equation
• Computer simulation

\[ \frac{DF}{TW} = \frac{TW \theta M}{A (1 - R^2)} \]
Section 7.2
Computer simulation
Section 7.3
Factors affecting the accuracy and reliability of computer predictions

• Model geometry
• Physical properties
• Luminous environment
• Sensor grid/points
• Simulation parameters
• Data output / presentation
Section 7.3.1
Model geometry
• Construction
• Complexity
• Good practice
• Walls - thick!

'Ground plane'
Section 7.3.2
Physical properties

- Diffuse / specular
- Typical values
- Glazing standard
- Advanced / complex fenestration

<table>
<thead>
<tr>
<th>Opaque surfaces</th>
<th>Typical reflectance range (%)</th>
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<tbody>
<tr>
<td>Ceiling</td>
<td>70–85</td>
</tr>
<tr>
<td>Walls</td>
<td>40–70</td>
</tr>
<tr>
<td>Floors</td>
<td>5–30</td>
</tr>
<tr>
<td>Ground</td>
<td>5–30</td>
</tr>
<tr>
<td>External facade</td>
<td>20–40</td>
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</table>

<table>
<thead>
<tr>
<th>Glazing</th>
<th>Typical light transmittance value(s)</th>
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<tbody>
<tr>
<td>Clear single glazing</td>
<td>0.88</td>
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<tr>
<td>Clear double glazing</td>
<td>0.79</td>
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<tr>
<td>Low-e double glazing</td>
<td>0.69</td>
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<tr>
<td>Solar control glazing</td>
<td>0.20–0.50</td>
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</tbody>
</table>
Section 7.3.3 / 7.3.4
Luminous environment

- Enclosing
- Sky models
- Ground plane
- LEED Clear sky options

Sensor grid/points

- 0.5m perimeter
Section 7.3.5
Simulation parameters

- Quality settings

**High quality simulation**
- Smooth shading/contours - pattern matches expectation
- High variance 'blotchy' output - counterintuitive patterns

**Poor quality simulation**
- Daylight factor [%]
  - 10.0
  - 1.0

Daylight factor [%]
- 10.0
- 1.0
Section 7.3.5
Simulation parameters

- Convergence testing
Section 7.3.6

Data output / presentation

- Perimeters
- Average vs. median

<table>
<thead>
<tr>
<th>Border</th>
<th>Mean</th>
<th>Median</th>
<th>Uniformity</th>
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<tr>
<td>0.1m</td>
<td>3.4%</td>
<td>1.7%</td>
<td>0.20</td>
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<tr>
<td>0.5m</td>
<td>2.9%</td>
<td>1.7%</td>
<td>0.23</td>
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</tbody>
</table>
Sections 7.4, 7.5 & 7.6
Modelling sunlight non-standard materials / structures & glare / discomfort

• Sunlight - largely qualitative (see CBDM)

Daylighting strategies

• Materials / structures: basic vs. advanced / complex

Visual discomfort / glare

• DGI, DGP
Section 7.7
Climate-based daylight modelling (CBDM)

- Climate data
- CBDM metrics
- Irradiation modelling / mapping
- CBDM simulation of glare (DGP)
CBDM metrics

Section 7.7.1

CBDM metrics

- Daylight autonomy (DA)
- Useful daylight illuminance
- Spatial DA IES-LM-83
- EFA PSBP
Sections 7.7.2, 7.7.3 & 7.7.4
Irradiation / illumination modelling / mapping

- Urban
- Inside buildings (case study 7.10.2)

Simulation of daylight glare probability

- Adaptive zone

User operation of blinds / shades

- Models
- Confounding factors
Modelling artificial lighting

- Luminaire data
- Choosing a software package
- Creating the model
Section 7.9
Lighting environmental and energy modelling

• Lighting control system modelling
• Lighting energy compliance modelling
• Lighting energy numeric indicator (LENI)
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Chapter 7: Lighting Modelling

Section 7.10
Case studies

• Evaluation of a classroom using UDI
• Daylight exposure study for conservation
• Urban daylight injury study
Summary and conclusions

• Major revision compared to 1998 AM11
• CBDM still evolving - new tools
• Compliance driven