Optimization of Atrium Skylight Baffles
14th International Radiance Workshop August 2015

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passive + low energy design
Office Design - Atria
Process Overview
Shading Design
HVAC Peak Capacity
Daylight conditions
Result
CONTEXT

Office building
- 67,000m²
- 11 floors
- 2 atria
- >17m floor depths
- temperate climate 1,700m altitude
- Johannesburg, South Africa
ATRIA – DESIGN TARGETS

Design
- Complement building design
- No blinds in atrium

Daylighting
- Glare
- “Useful” Daylight

HVAC Peak capacities
PROCESS OVERVIEW
PROCESS OVERVIEW

Optimization of Atrium Skylight Baffles
SHADING DESIGN
DAYLIGHT CONDITIONS

Optimization of Atrium Skylight Baffles
Optimization of Atrium Skylight Baffles
SHADING DESIGN

- Proportion
- Height / Distance
- Rotation (z-axis)
- Material
Optimization of Atrium Skylight Baffles

- Rhino
- Grasshopper
- DIVA
- Ladybug
- Honeybee
SHADING DESIGN – PROPORTION

This diagram shows the analysis of a grid with one meter by one meter. It shows the height on each point that is needed to avoid glare.
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GLARE ANALYSIS
SHADING DESIGN - ROTATION

304 Glare hours

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SHADING DESIGN - ROTATION

North Atrium
HVAC PEAK CAPACITY
HEAT EXTRACTION DESIGN

Direct light/radiation

Smoke exhaust system

Atrium air extracted through baffles

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BAFFLE MATERIAL

TRL Fabric
Transmission: 42%
Reflection: 52%
Absorption: 6%
RADIATION ANALYSIS
RADIATION ANALYSIS

Total Radiation [W/m²]
With baffles

Radiation absorbed by baffles

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RADIATION ANALYSIS

1 JAN 6:00
Max 0 W/m²
Optimization of Atrium Skylight Baffles

PARAMETRIC HEAT EXTRACTION DESIGN

Parametric input:

TRL Fabric
Transmission: 42%
Reflection: 52%
Absorption: 6%

Clear Glass:
SC: 0822
Tvis: 0.847

Grey Glass:
SC: 0.645
Tvis: 0.503
<table>
<thead>
<tr>
<th>North East Skylight</th>
<th>Clear Glass SC</th>
<th>0.822</th>
<th>Tvis=0.847</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky North Peak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sky South Peak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Required Reduction by baffle</td>
<td>152.617</td>
<td>130.126</td>
<td>32.297</td>
</tr>
<tr>
<td>South Required Radiation to be dealt with by HVA</td>
<td>22.00158</td>
<td>113.481</td>
<td>63.7961</td>
</tr>
<tr>
<td>South Maximum Radiation allowed</td>
<td>80.1562</td>
<td>32.40</td>
<td>35.59</td>
</tr>
<tr>
<td>South Maximum Airflow allowed</td>
<td>31.34</td>
<td>32.34</td>
<td>32.34</td>
</tr>
<tr>
<td>South Maximum SC</td>
<td>94.5993</td>
<td>94.5993</td>
<td>94.5993</td>
</tr>
<tr>
<td>South Effective SC</td>
<td>94.5993</td>
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<td>94.5993</td>
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<tr>
<td>South Resulting air temperature</td>
<td>36.1487</td>
<td>36.1487</td>
<td>36.1487</td>
</tr>
<tr>
<td>South Resulting air infiltration</td>
<td>36.1487</td>
<td>36.1487</td>
<td>36.1487</td>
</tr>
<tr>
<td>South Resulting infiltration</td>
<td>36.1487</td>
<td>36.1487</td>
<td>36.1487</td>
</tr>
</tbody>
</table>

Optimization of Atrium Skylight Baffles

Heat Extraction Design - Results

| Date      | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TRL | Date | x%TRL | x%TROL
HEAT EXTRACTION DESIGN - RESULTS

Input:

Exhaust temperature for option A and B

Is the temperature below the maximum allowed temperature?

Output:

Option B
RESULTING GEOMETRY
DAILIGHT CONDITIONS
DIA LIGHT ANALYSIS

DIVA-for-Rhino Illuminance Nodes Analysis
Sky Condition, Month, Date and Time: 09 21 12
nodegroup00: Mean Illuminance = 229.59 lux
nodegroup00: 69.9% of Area between 0 & 250 lux
nodegroup00: 30.1% of Area > 250 lux; 0% of Area < 0 lux

Radiance render – Easterly view

8th Floor
GREEN STAR – SPATIAL DAYLIGHT AUTONOMY (SDA)

4th floor

DIVA-for-Rhino Simulation
Daylight Autonomy (300 lux, IES-LM-83 sDA control schema)

nodegroup01: Percent of Space where sDA >= 50% is 14.3 % of space
nodegroup02: Percent of Space where sDA >= 50% is 11.2 % of space
nodegroup03: Percent of Space where sDA >= 50% is 4.6 % of space
nodegroup04: Percent of Space where sDA >= 50% is 25.6 % of space

6th floor

DIVA-for-Rhino Simulation
Daylight Autonomy (300 lux, IES-LM-83 sDA control schema)

nodegroup00: Percent of Space where sDA >= 50% is 11.6 % of space

8th floor

DIVA-for-Rhino Simulation
Daylight Autonomy (300 lux, IES-LM-83 sDA control schema)

nodegroup00: Percent of Space where sDA >= 50% is 12.3 % of space

Optimization of Atrium Skylight Baffles
FINAL RESULT
ACKNOWLEDGMENTS
- PARAGON ARCHITECTS
- ARE HVAC ENGINEERS
- NAVID HATEFNIA
QUESTIONS?