Façade Engineering and Building Physics

examples of current best practice and recent innovations

Mikkel Kragh, Associate, Arup
PhD MSc CEng MCIBSE FSFE
Chairman, Society of Façade Engineering
Overview

• Introduction
• Arup
• Facade Engineering
• Two Case Studies
• Innovation Example
Designing for Climate

“The first American house built in war-time Java completely bewildered natives there. Instead of building walls of local bamboo, which is closely spaced to keep out rain while admitting light and air, the white man put up solid walls to keep out light and air, and then cut windows in the walls to admit the light and air. Next, he put glass panes in the windows to admit light but keep out the air. Then, he covered the panes with blinds and curtains to keep out the light too.”

Ken Kerr, 1978
Arup was established in 1946 in the United Kingdom to provide a completely independent professional consulting engineering service.
“A design team which produces a total, balanced, efficient design can help to produce a better environment”

Sir Ove Arup
Arup is no ordinary firm

We are an independent firm of designers, planners, engineers, consultants and technical specialists offering a broad range of professional services. Through our work, we make a positive difference in the world.

We shape a better world
facade engineering
The ‘Impact’ of Building Envelopes

- 15% - 25%+ of construction costs
- Interfaces “It’s where the problems always arise…”
- Appearance of building
- Filter inside/outside
- Added value
- Reduced risk
- Control costs
Architecture

Commodity
Firmness
Delight

[ Vitruvius ]
Façade Engineering

• ‘Grey area’
• From traditional to non-traditional methods and technologies
• Multitude of specialist skills, knowledge, and intelligence about industry
• Emerging specialist ‘discipline’
• Qualifications?

INTEGRATED FACADE SYMPOSIUM | San Francisco | 21 APRIL 2010
Society of Facade Engineering

FACTS: Established in 2003. CIBSE Society. Supported by RIBA and IStructE. Growing membership across industry and regions. Currently around 250 members (Affiliate / Associate / Member / Fellow).


www.FacadeEngineeringSociety.org
a couple of projects
Plantation Place
Arup Associates

Plantation Place:
An exemplar of the versatility of glass in 21st Century architecture
Plantation Place, London EC3

Arup Associates
Massing

Height Restriction +70.0M

Fresh Air + Breezes.

cross ventilation

Garden

Air Con

Sealed Facade

Existing Buildings

Noise + Dint.
Massing

Height Restriction +70.0m
Fresh Air + Breezes.
cross ventilation
perimeter ventilation

Garden

Northeast+Dirt

Sealed Facade

Existing Buildings

Noise + Dirt

AirCon

Arup Associates
Plantation Place, London EC3

Arup Associates
Internal Anatomy

Arup Associates
The Lower Levels

Arup Associates
Lower Levels cladding system
Lower Levels cladding system

Arup Associates
Upper Levels cladding system

Arup Associates
Upper Levels cladding system

Arup Associates
Upper Levels cladding system

Arup Associates
Upper Levels cladding system

Arup Associates
Upper Levels cladding system

Arup Associates
The Garden in the Sky

Arup Associates
Upper Levels cladding system

Arup Associates
Plantation Place South

Arup Associates
Plantation Place South

Arup Associates
Plantation Place South

Arup Associates
INTEGRATED FACADE SYMPOSIUM | San Francisco | 21 APRIL 2010
Ropemaker Place
Building Physics Report—Stage C Rev 02

The adjacent sketches show how the proposed geometry will increase the surface area of the building significantly. This increased surface area will result in more heat loss through the building envelope than with an equivalent flat building façade.

In order for the energy model to be able to compare the two scenarios of a flat façade and a serrated one, the serrated façade has been given an equivalent U-value for the flat projected area of the façade.

For simplicity and in order to facilitate comparison and further processing of the results, the increased transmission area of the proposed design has been translated into a corrected (or a "projected") U-value in the plane of the façade. These performance are as follows:

1. Flat Façade, Base Case \( U_{\text{projected}} = 1.7 \text{W/m}^2\text{K} \)
2. Serrated Façade, Design Target \( U_{\text{projected}} = 2.0 \text{W/m}^2\text{K} \)

The target U-value is based on estimates of likely component performance and area weighting. Subsequent studies will focus on the detailing of the curtain wall and the target will be adjusted as required.

A description of the energy modelling carried out to date and the assumptions made to date follows on the next pages, along with our preliminary results which suggest significant reductions in the annual cooling energy load on the East, South and West elevations.

Comparative Façade Area for Energy Model
Basic assumptions
- $U_{glass} = 1.40 \text{ W/(m}^2\text{K)}$
- Air filled DGU, high performance coating 68/34
- Aluminium spacer tube
Ropemaker Place

Building Physics Report—Stage C Rev 02

The adjacent diagrams illustrate the operational profiles assumed in the energy model for all of the three scenarios. The basic assumptions can be summarised as follows.

1. The SBEM Standard scenario
   - Weather file: CIBSE London TRY 2006
   - Occupancy: 0m²/person
   - Lighting: 18.75W/m²
   - Equipment / small power: 15W/m²
   - Heating set point: 22°C
   - Cooling set point: 24°C
   - Infiltration: 0.15 m³/h
   - Ventilation: 9 l/s/person
   - Perimeter zone: 6.0 m

2. The Client’s Brief scenario
   - Weather file: CIBSE London TRY 2006
   - Occupancy: 10 m²/person
   - Lighting: 12W/m²
   - Equipment / small power: 25W/m²
   - Heating set point: 21°C
   - Cooling set point: 22°C
   - Infiltration: 0.15 m³/h
   - Ventilation: 10 l/s/person
   - Perimeter zone: 4.5 m

3. The Low Energy Tenant scenario
   - Weather file: CIBSE London TRY 2006
   - Occupancy: 0 m²/person
   - Lighting: 8W/m²
   - Equipment / small power: 7.5W/m²
   - Heating set point: 22°C
   - Cooling set point: 24°C
   - Infiltration: 0.15 m³/h
   - Ventilation: 9 l/s/person
   - Perimeter zone: 4.5 m

Limited cooling capacity: 89 W/m² (assumed)

Energy Study — Assumptions
British Land
Ropemaker

Our new development at Ropemaker, London EC2, has been designed to provide an attractive and sustainable building for occupants, meeting their needs today and tomorrow.

With planning approved in April 2007, the 20 storey building will provide 550,000 sq ft (50,000m²) of office and retail space, including two trading floors of 45,000 sq ft (4,200m²).

It has been designed by Arup Associates for a range of occupiers and construction has begun with completion scheduled for mid 2010.

15% lower CO₂
Ropemaker is designed to achieve 15% lower predicted carbon emissions than set out in the Building Regulations.

BREEAM
The development is expected to achieve an Excellent BREEAM rating. BREEAM is the most widely used environmental assessment method for buildings. For more information visit www.breeam.org

50% green roof
We are designing 50% of the available roof space as green roof. The green roof area will also be carefully landscaped with plants and soil over a waterproofing membrane to enhance biodiversity.

Developing sustainable buildings
“We aim to lead the market in developing and managing buildings in a sustainable manner. By financing, developing and managing properties that responsibly utilise energy, water and waste, we conserve the world’s resources and can also reduce our costs and those of our occupants.”

Stephen Hecker, Chief Executive

In 2008 we revised and improved the Brief following an Independent Review. We also developed a Sustainability Brief for the Building Management System and a Sustainability Guide for occupiers. You can download these documents from www.britishland.com/downloads.

British Land’s Ropemaker development incorporates a wide range of sustainability measures. These will enable occupiers to reduce energy and water use, cut down waste, decrease carbon emissions and lower associated costs.

Managing energy
Climatic and shading strategies will reduce heating and cooling requirements. The building is designed to install low energy, shading and lighting systems. There will be the option to use solar panels for heating and cooling.

Managing waste
Managing waste responsibly will help to safeguard the world’s valuable resources and reduce the costs of transport, materials and disposal. Materials from demolition have been recycled and reused. Relocatable and transportable systems are used to reduce waste to landfill.

Sustainable travel
Encouraging occupants and visitors to use public transport and bicycles will reduce car use and associated emissions. Ropemaker is located close to excellent public transport links, including mainline stations and London Underground stations. The development will also feature cycle storage and shower facilities.

Managing water use
Encouraging water saving measures and introducing metering will reduce water requirements and minimise Ropemaker’s impact on local drainage systems. When water shortage is probable, through metering tied to the Building Management System, water usage will be monitored through meters tied to the Building Management System. Rainwater will be collected and re-used in flush WC’s.

Managing biodiversity
Enhancing the local ecosystem at Ropemaker will add to its attractiveness as a place in which to do business. Designating 50% of the available roof space as green roof will enhance biodiversity, provide an attractive area for occupiers and improve the appearance of the building.
innovation example
“"He who innovates will have for his enemies all those who are well off under the existing order of things, and only lukewarm supporters in those who might be better off under the new.”

Niccolo Macchiavelli (adapted from Gordon Graham, 2008)
The Integrated Building Envelope

www.IntegratedBuildingEnvelope.com
Innovation

- Curtain Walling
- Pultruded GFRP
- Consortium
Consortium

Arup
Permasteelisa
Fiberline
Art Andersen
3XN
Make
Cabot

BYGGERIETS/INNOVATION
BUILDING LAB DK
<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Maximum height</td>
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<tr>
<td>Minimum corner radius</td>
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<tr>
<td>Transverse ribs</td>
<td>Yes</td>
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<tr>
<td>Surface mats</td>
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<tr>
<td>Maximum width</td>
<td>1250 mm</td>
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<tr>
<td>Variation in thickness</td>
<td>Yes</td>
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<tr>
<td>Inclusions of conductor or resistor</td>
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<td>Directional strength and stiffness</td>
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<td>Maximum thickness</td>
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<tr>
<td>Normal thickness tolerance</td>
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<tr>
<td>Option of alternative coatings</td>
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<td>Minimum thickness</td>
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<tr>
<td>Supplementary fabrication</td>
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<tr>
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pushing the envelope

natural ventilation

mechanical ventilation

photovoltaics

flexible

translucency

fluidised

dynamic insulation

double skin

intelligent

vacuum insulation

phase change

randomisation

media

dichromic

heating

blast resistant

switchable

reuse

recycle

cooling

solar thermal

complex geometry

louvres

shutters
Idea

- Low thermal conductivity
- Large pultruded sections
- Compact (slim) system
- Structurally bonded
- Lightweight
- Limited number of parts
- Appearance
### Integrated Facade Symposium

**GARTNER**

#### Table: Sound Reduction Index $R$ [dB]

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<th>$f$ [Hz]</th>
<th>$R$ [dB]</th>
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#### Graph: Sound Reduction Index $R$ vs Frequency $f$ [Hz]

- **picture No. 1:** GFK-panel
- **picture No. 2:** GFK-panel with mineral wool filling
- **picture No. 3:** GFK panel in test opening
- **picture No. 4:** GFK panel with glass pane ahead
studies by MAKE architects
Collaboration
Façade Engineering and Building Physics

examples of current best practice and recent innovations

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ARUP