

# Technical constraints and strategies for building envelope design

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# BIFF FACADE CONSULTANT

## Swiss global specialist for façade envelopes

### New construction & refurbishment complex projects.



- **TECHNICAL ANALYSIS:**
- Engineering and technical design development for bespoke façade projects.



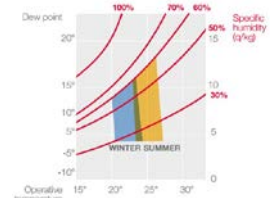
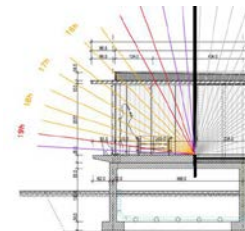
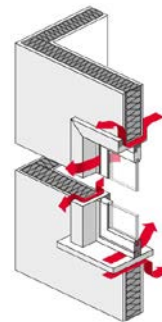
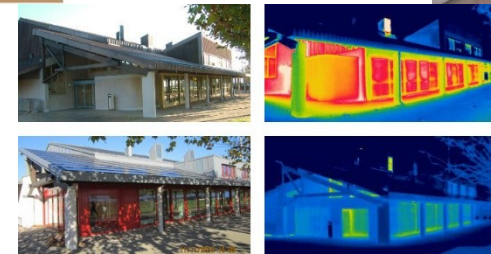
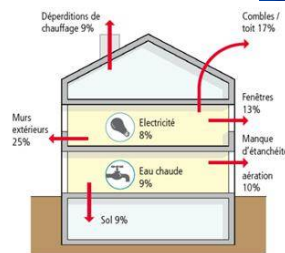
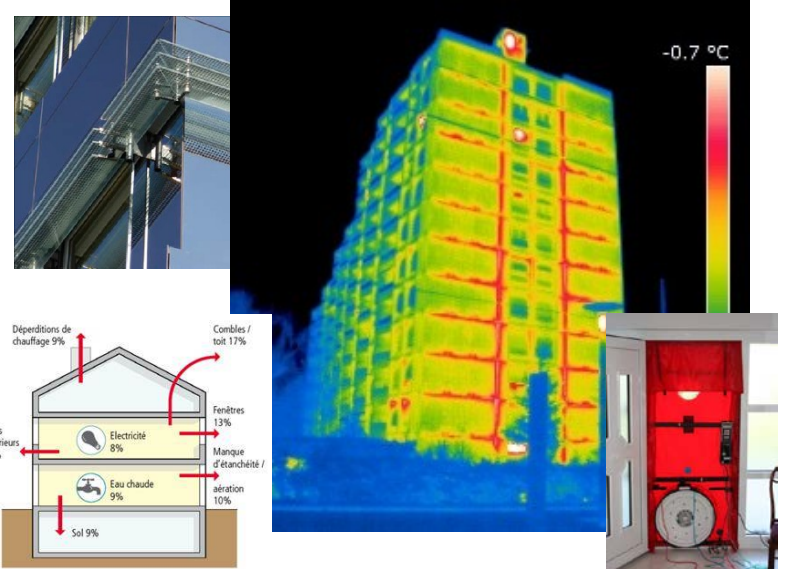
- **BUILDING PHYSICS:**
- Studies and analyses of existing buildings achieving tailored sanitation solutions



- **WORKS SUPERVISION:**
- Project management and prototype supervision with special attention to programme and cost



- **EXPERTISE**
- Determinate faults, seek out their cause, suggest remedies and budgeting cost repair. Address responsibility.



# Design key points of refurbishment projects

- Total or partial refurbishment
- Envelope performance improvement and aesthetics objectives.
- Client's strategic goals
- Client's budget awareness

Project type & client's necessities

- Determine faults
- Enquiry current users about main issues. (thermal, comfort, water leaks, etc.)
- Required maintenance

Existing conditions

Envelope audit

Technical concept study

Ensure Client's necessities accomplished

Present several possibilities and budgets

Refurbishment options & strategies

- Standards
- Envelope performance (thermal, light, water tightness, air permeability, resistance, acoustics, fire, security, building movements, etc.)
- Local authorities (aesthetics, performance, room, etc.)
- Site conditions (access, plant, etc.)

Design technical constraints

- Present different refurbishment options along with budgets estimations
- Building up a programme of works
- Take advantage of all existing elements

# Design key points of refurbishment projects

## BIT - Geneva



### Envelope refurbishment constrains

- Largest administrative building in Switzerland
- Historic building: Identical aesthetics and geometry
- Large project with several phases
- High raise building and scaffoldings
- Presence of hazardous materials
- Structural façade elements
- Alcast elements installed in the 70's
- Improve global performance: thermal, comfort, acoustic, security, life expectancy, etc.

### Main decisions and strategies

- Defining required properties within a Swiss changeable environment.
- Window type: Breathing windows with internal openable leaf for blinds access.
- Scaffolding installation and Alcast cleaning.
- Removing dangerous materials and their contribution to the fire performance.
- Structural façade performance and current standards.



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# Design key points of refurbishment projects

## BIT - Geneva

| ANALYSE MULTICRITERES |                                     |             |               | A-A                |              | B-B                             |              | C-C        |              |
|-----------------------|-------------------------------------|-------------|---------------|--------------------|--------------|---------------------------------|--------------|------------|--------------|
|                       |                                     |             |               | Soumission de BASE |              | VATIANTE 1 : FENETRE RESPIRANTE |              | VARIANTE 2 |              |
|                       |                                     |             |               |                    |              |                                 |              |            |              |
| N°                    | Critères                            |             | %             | Note               | Résultat     | Note                            | Résultat     | Note       | Résultat     |
| 1                     | Architecture                        | 400         | 20.0%         | 10                 | 4000         | 7                               | 2800         | 7          | 2800         |
| 2                     | Fonctionnalité                      | 300         | 15.0%         | 10                 | 3000         | 7                               | 2100         | 10         | 3000         |
| 3                     | Système statique                    | 10          | 0.5%          | 10                 | 100          | 7                               | 70           | 7          | 70           |
| 4                     | Résistance des matériaux            | 10          | 0.5%          | 10                 | 100          | 10                              | 100          | 10         | 100          |
| 5                     | Isolation thermique hiver           | 50          | 2.5%          | 10                 | 500          | 7                               | 350          | 7          | 350          |
| 6                     | Isolation thermique été             | 50          | 2.5%          | 10                 | 500          | 7                               | 350          | 7          | 350          |
| 7                     | Inertie thermique                   | 50          | 2.5%          | 10                 | 500          | 7                               | 350          | 7          | 350          |
| 8                     | Protection solaire                  | 50          | 2.5%          | 10                 | 500          | 7                               | 350          | 7          | 350          |
| 9                     | Etanchéité à l'eau                  | 100         | 5.0%          | 10                 | 1000         | 4                               | 400          | 4          | 400          |
| 10                    | Perméabilité à l'air                | 100         | 5.0%          | 10                 | 1000         | 7                               | 700          | 7          | 700          |
| 11                    | Protection acoustique int-ext       | 10          | 0.5%          | 10                 | 1000         | 7                               | 700          | 7          | 700          |
| 12                    | Protection acoustique étage         | 50          | 2.5%          | 10                 | 1000         | 7                               | 700          | 7          | 700          |
| 13                    | Protection acoustique raccord paroi | 100         | 5.0%          | 10                 | 1000         | 4                               | 400          | 4          | 400          |
| 14                    | Dilatation                          | 10          | 0.5%          | 10                 | 1000         | 10                              | 1000         | 10         | 1000         |
| 15                    | Protection feu                      | 10          | 0.5%          | 10                 | 1000         | 7                               | 700          | 7          | 700          |
| 16                    | Mise à terre                        | 50          | 2.5%          | 10                 | 1000         | 1                               | 100          | 1          | 100          |
| 17                    | Nettoyage des coques Alcast         | 50          | 2.5%          | 10                 | 1000         | 4                               | 400          | 4          | 400          |
| 18                    | Mise en œuvre                       | 100         | 5.0%          | 10                 | 1000         | 4                               | 400          | 4          | 400          |
| 19                    | Durée de vie                        | 100         | 5.0%          | 10                 | 1000         | 7                               | 700          | 7          | 700          |
| 20                    | Energie grise                       | 100         | 5.0%          | 10                 | 1000         | 10                              | 1000         | 10         | 1000         |
| 21                    | Ecobilan                            | 100         | 5.0%          | 7                  | 700          | 7                               | 700          | 7          | 700          |
| 22                    | Santé des collaborateurs            | 100         | 5.0%          | 10                 | 1000         | 10                              | 1000         | 10         | 1000         |
| 23                    | Attaches échafaudages               | 50          | 2.5%          | 10                 | 1000         | 1                               | 100          | 1          | 100          |
| 24                    | Entretien                           | 50          | 2.5%          | 10                 | 1000         | 4                               | 400          | 7          | 700          |
| <b>TOTAL</b>          |                                     | <b>2000</b> | <b>100.0%</b> |                    | <b>24900</b> |                                 | <b>15870</b> |            | <b>17070</b> |
| <b>Notes</b>          |                                     |             |               | <b>9.9</b>         |              | <b>6.3</b>                      |              | <b>6.8</b> |              |



# Design key points of refurbishment projects

## Swissair – IATA center at Geneva Airport



IATA's skylight before refurbishment

- **Double skin roof light above open space offices**
- **Technical issues**
  - Maintenance of solar protection
  - Water leaks
  - Condensation
  - External protection film damaged
- **Consequences**
  - Thermal comfort complaints
  - No proper daylight control
  - Aesthetics
- **Renovation concept's constrains**
  - Airborne noise from airport
  - Open spaces occupied

# Design key points of refurbishment projects

## Renovation options



### Option 1

Standard insulated glazing unit  
with reflective films

- **Strengths:**
- Average costs
- Simple & classical solution
- **Weaknesses:**
- Reflective films airport authorizations
- Exposed to weather conditions
- Predictable maintenance - 10 years
- Thermal loss
- No adaptive system (reduced comfort)
- Sun protection still required



### Option 2

Electronically tintable glass

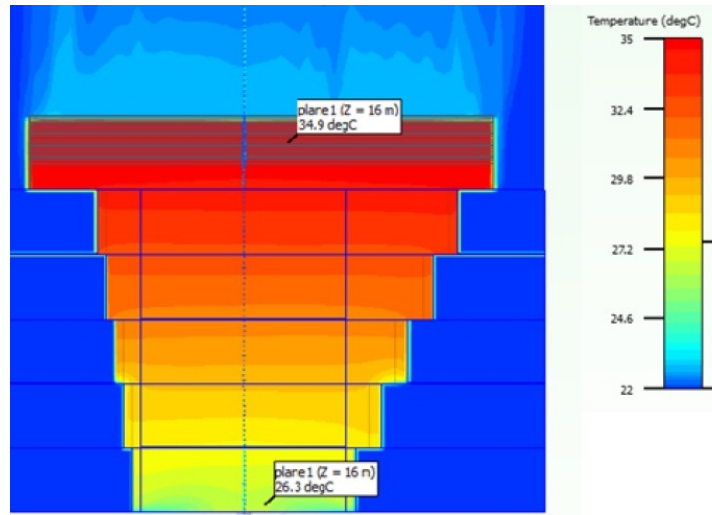
- **Strengths:**
- Average costs
- Excellent energy efficiency. Refund of 25% of investment compared to option 1
- Adaptive system with daylight control.
- No classical sun protection required
- No maintenance
- **Weaknesses:**
- Cables routing
- Economic investment sensibly higher
- New solution in Switzerland

# Thermal & CFD simulation: optimising envelope performance

- Renovation “standard”
- new glazing,
- new sun protection films
- new movable blinds

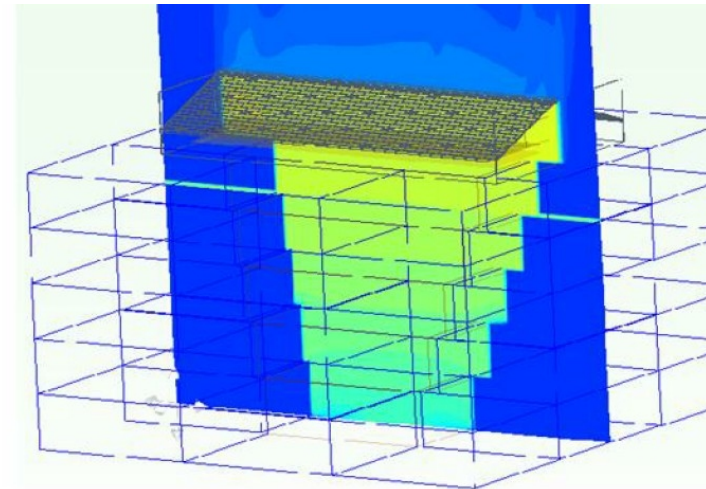
Floors

6th  
5th  
4th  
3rd  
2nd  
1st



- **Renovation**
- Temperature 35°C
- Energy loss 1
- Comfort Ok
- Light control On/Off
- Thermal insulation  $U_g$  0,6 W/m<sup>2</sup>k
- Solar factor  $g$  0,20
- Next Maintenance 10 years

- Renovation Electrochrome
- Dynamic triple glazing
- Automatic control
- No mechanical parts



- **Electrochrome**
- 29°C
- -60% cooling
- Ok plus
- Dimming
- 0,6W/m<sup>2</sup>k
- 0,03
- 30 years



# Design key points of refurbishment projects Marcelin High School – SWITZERLAND



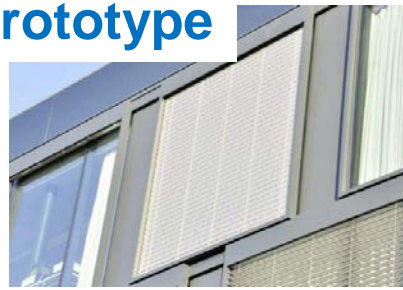
## Old situation

- Outdoor fabric sun protection
- No effective solar protection
- High internal thermal loads
- Wind speed limitations

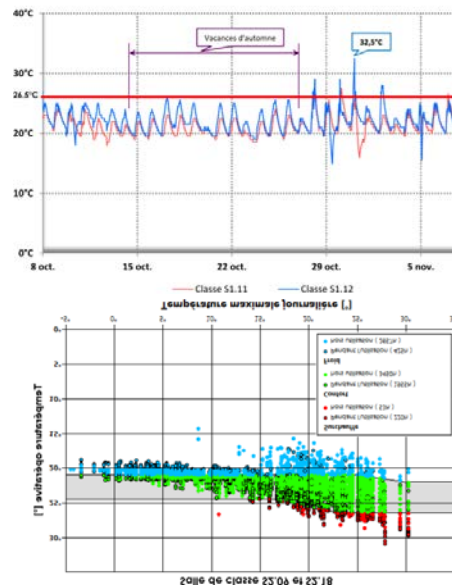
## Simulations results:

- More than 100 days per year without sun protection due to wind speed.
- Temperature higher than 26,5 °C for more than 230 hours / year.
- Recorded temperature up to 32,5°C.

## Prototype



- CFD calculations for determination internal comfort.
- Temperature simulations.
- Data loggers



## Current situation

- Effective solar protection
- Outdoor sun protection blinds
- Wind speed resistance up to 90 km/h

## Simulations results:

- About 15 days/year without sun protection blinds, but lower temperatures outside.
- Temperature higher than 26,5 °C for 30 hours / year.
- Reduction of 3-4° average temperature.

# Blast & fire resistant façades optimisation

## Pont Rouge - Geneva

### NEW REGULATIONS – OPAM (Prevention Organism of Major Accidents)

#### Railway hazards:

- Inflammable liquids: Fuel, kerosene, methanol, acetone, etc.
- VCE explosion: Propane, hydrocarbures, vinylchlorid, etc.

#### Several architectural strategies:

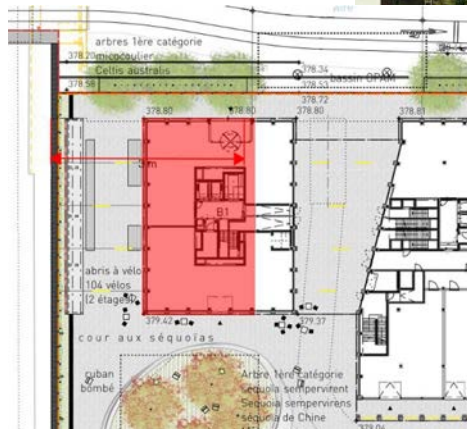
- Create retention walls
- Increase distance to hazards
- Reduce type and quantity of dangerous materials
- Change building activity
- Scape ways to protected areas

#### Several envelope strategies:

- No openable windows
- No combustible materials
- Envelope performance

#### Required façade performance:

- Affected façades, up to 30m from the railway.
- Fire performance EI30
- Blast performance 500 mbar



**B I**

**F F**



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# Blast & fire resistant façades optimisation Pont Rouge - Geneva



# Blast & fire resistant façades optimisation

## Pont Rouge - Geneva

### BLAST SIMULATIONS

#### ISSUES

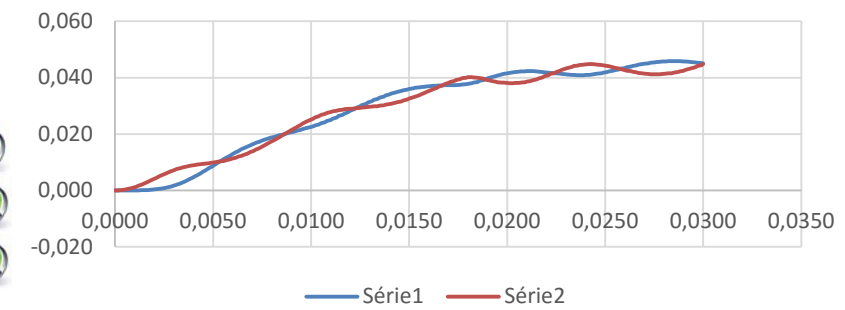
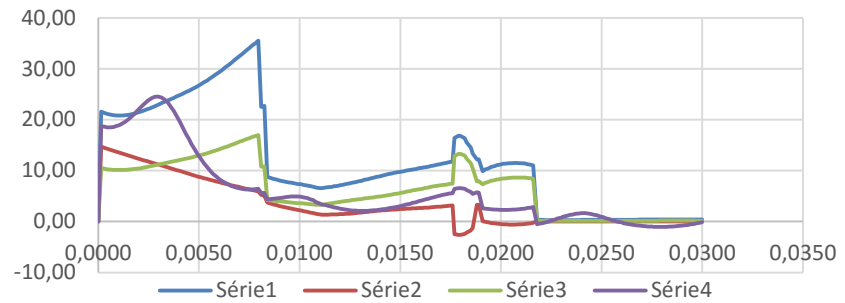
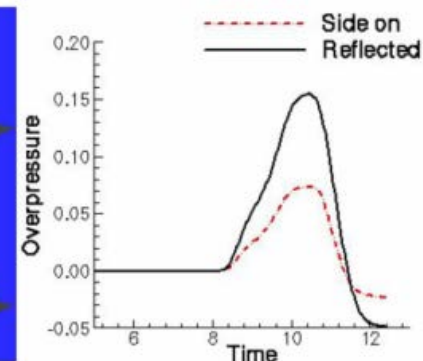
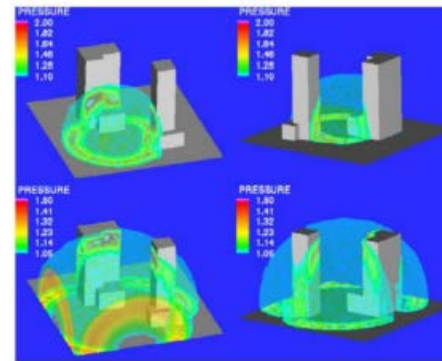
- No accredited solutions both for fire and blast resistance.
- Architectural constrains with large size panes
- High budget estimations

#### Research and simulations:

- Market research for EI30 solutions, dimensions and contact with authorities.
- Determination of blast threat (VCE) and envelope required performance.
- Dynamic non linear simulations and determination of envelope response.
- Design and concept adaptations

#### Conclusions:

- Glass composition changes, fundamentally EI30.
- Increase general resistance of steel, wood and aluminum systems.
- Bonding some glasses to the frames.
- Adapting and enhancing fixings and connections.
- NO FUNDAMENTAL ADAPTATIONS FOR ARCHITECTURAL CONCEPT.
- COST ESTIMATIONS RELATIVELY LIMITED.
- CURRENTLY IN CONSTRUCTION PHASE.



— Série1 — Série2



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# Blast & fire resistant façades optimisation

## Concorde - Geneva

### FIRE SIMULATIONS

#### Roadway hazards:

- Inflammable liquids: Fuel due to truck accident.

#### No many architectural options:

- Create retention walls
- Escape areas located in the back road
- Increase distance to the risk but hazard at 3m.

#### No many envelope strategies:

- Simple flow ventilation so openable windows
- No combustible materials

#### Required façade performance:

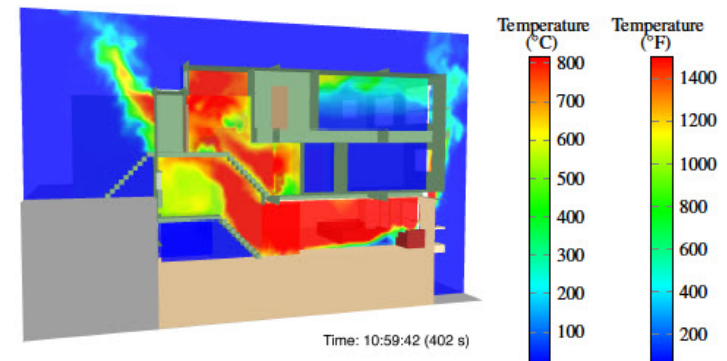
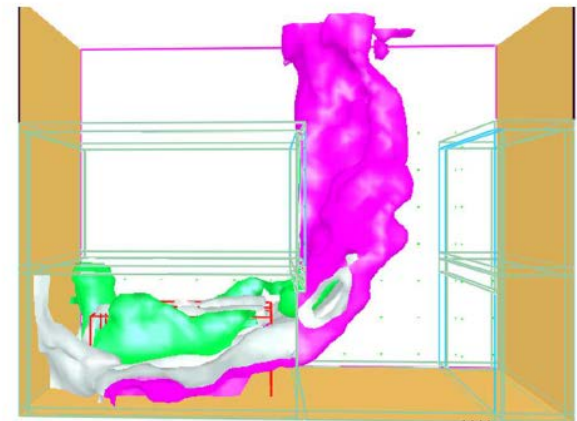
- Affected façades, almost 50% of façades surface
- Fire performance EI30

#### Research and simulations:

- Fire CFD calculation to determinate radiation expositions and time history for the different façade areas and levels.
- Research possible adapted products in the market.
- Completion of fire study for the full façade system.

#### Conclusions:

- Under some conditions standard products can be suitable for behaving this kind of hazard.
- Reduction of façade surfaces with EI30



# Blast & fire resistant façades optimisation Concorde - Geneva

THANK YOU

QUESTIONS?



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