Refurbishment considerations

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Introduction

- Refurbishment / cut carve/ retrofit is an ever-increasing project sector.
- Existing fabric retention, upgrading and renovation is no longer an afterthought but an integral part of project brief and concept.
- Risks inherent with existing fabric require different approaches for different types of façade and different key project drivers.

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3 different refurbishment projects:

- **50 Berkeley Street** – Historic solid wall considerations and the importance of surveys
- **New Zealand House** – Solar performance of an early post war Grade II listed glazed office tower
- **Woolgate Exchange** – Glazing thermal performance improvement studies for <25 year old office building

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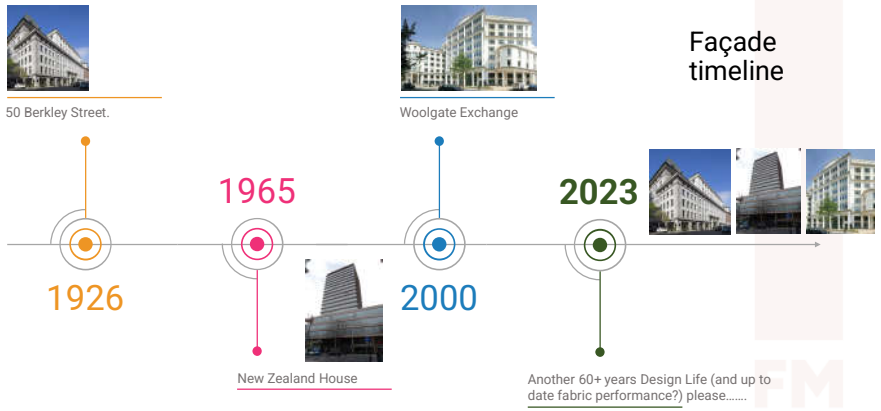

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50 Berkely Street

Built ca 1926

Extended ca. 1950's 1970's

Refurbished ca.2000

2023 refurbishment TEAM:

- Client – Berkely Estates Asset Management (BEAM).
- Architect- Stiff & Trevillion / Veretec
- Main Contractor – BAM construction
- Structural Engineer – HTS
- M&E / Sustainability - NDY

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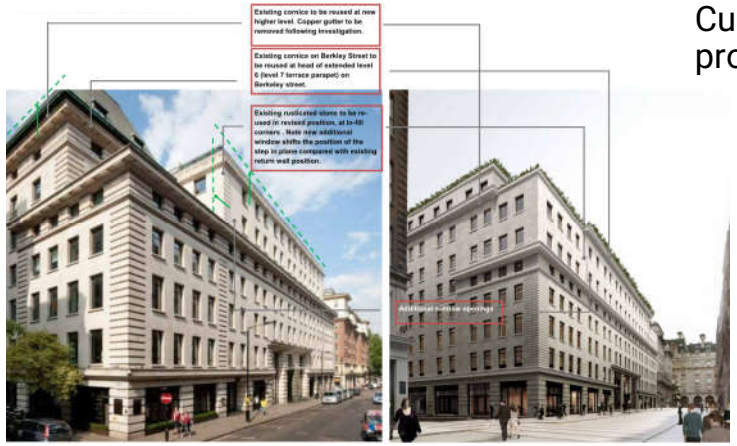
Current proposals



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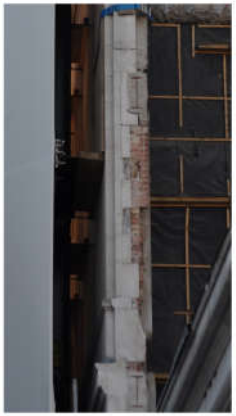
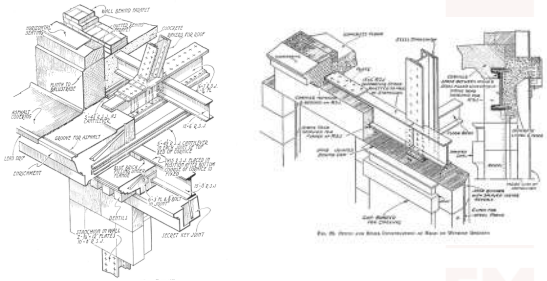


'Mass masonry wall' construction seen on a cutaway section through a retained historic façade.

Existing details



Extracts from "Modern Practical Masonry" (E.G Warland 1953)

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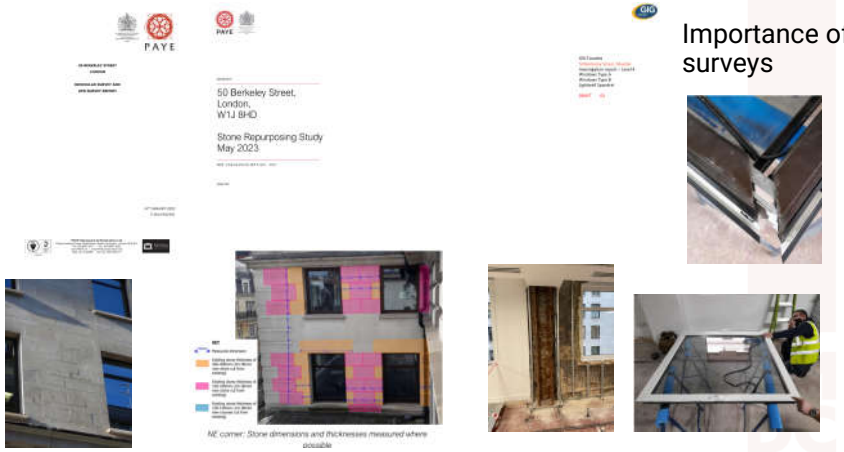
Importance of surveys



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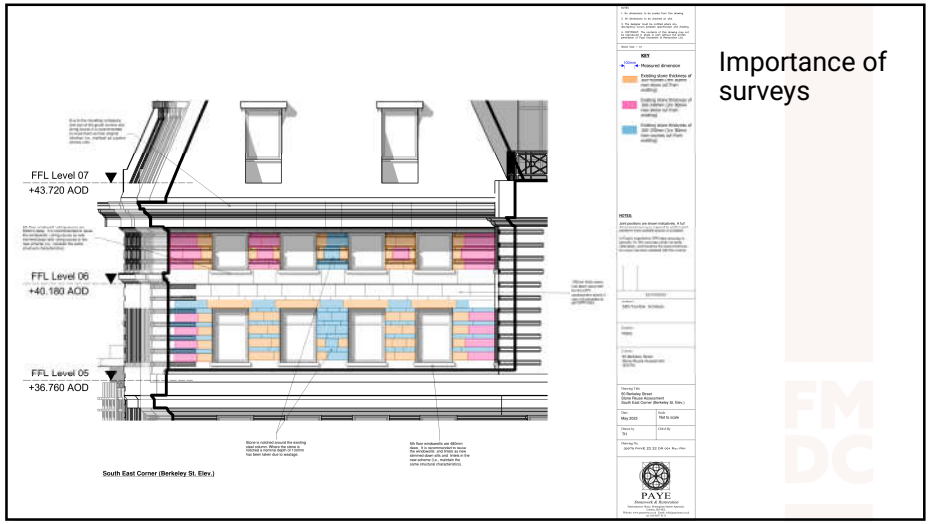

Importance of surveys

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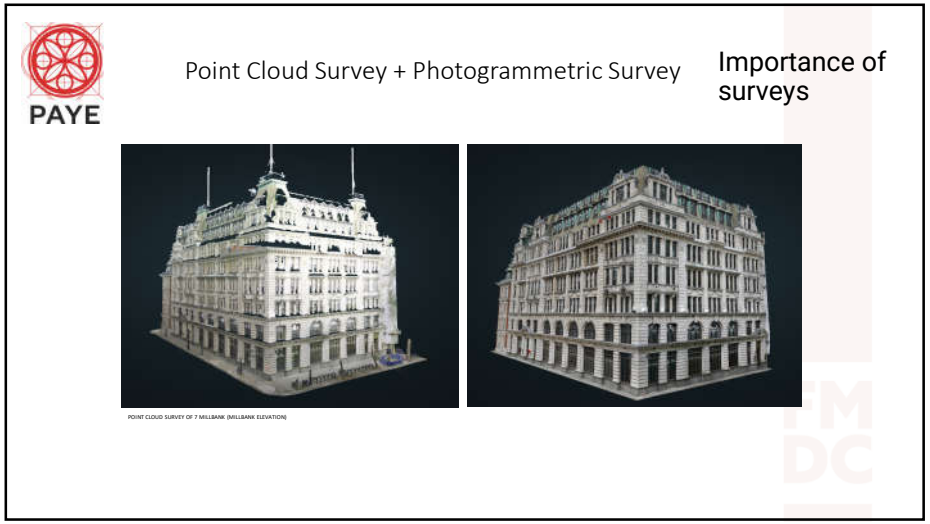

Importance of surveys

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Importance of surveys

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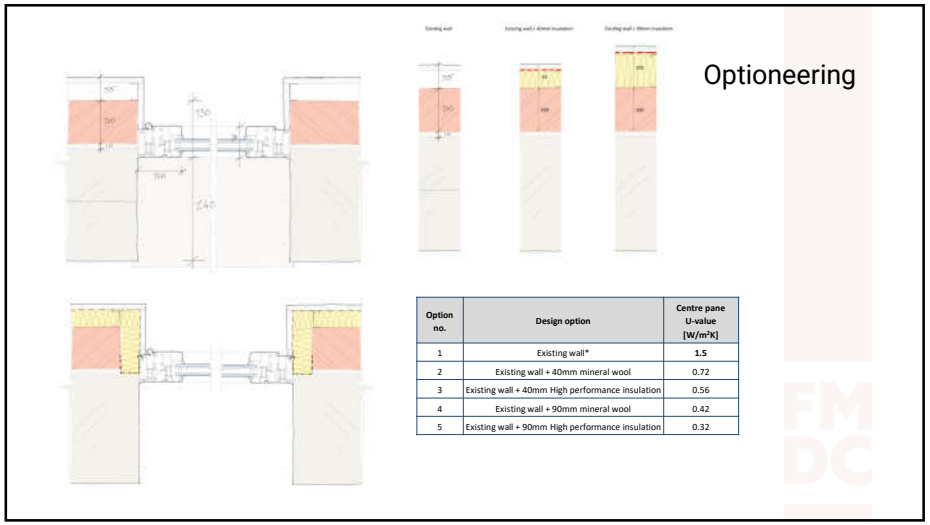

Optioneering

Option no.	Design option	Centre pane U-value [W/m²K]
1	Existing wall*	1.5
2	Existing wall + 40mm mineral wool	0.72
3	Existing wall + 40mm High performance insulation	0.56
4	Existing wall + 90mm mineral wool	0.42
5	Existing wall + 90mm High performance insulation	0.32

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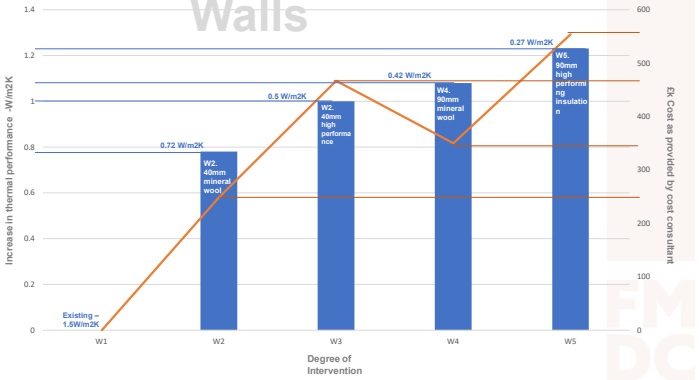
Notes:
- ** More than 40mm insulation will result in a reduction in net lettable area.
- No current regulatory requirement to insulate the existing walls
- *Allowances should be made for new dry lining where appropriate.
- Marginal gains in terms of planning and BREEAM to providing insulation.
- Remedial measures now or during CAT B works could trigger upgraded thermal requirements to minimum standards (to new Part L)
- Consideration required if insulation will be appropriate for the historic façade and not cause long term problems.
- Will require rebating the existing masonry around window interfaces.

Optioneering

Walls



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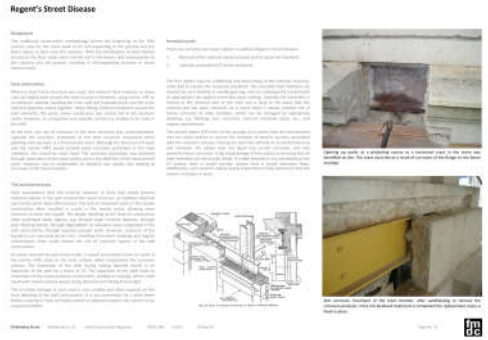
Optioneering

Hygrothermal behaviour of solid walls with embedded steel structure?



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Optioneering

Solid Walls

	Advantages	Whole Life Carbon Balance (A-C) (tC02) info from NDY study.	Disadvantages
W1. Keep existing walls and dry lining	• Minimum embodied carbon • Minimum expenditure • Minimum risk of introducing problems for embedded steel structure. • Will not trigger minimum requirements for part L for 'upgrading' of thermal elements.	NDY	• Poor u-value. • Risk of non-compliance with future revisions of building regulations. • Increased energy in-use requirement. (heating demand) • Tricky interface details with new construction which will be insulated.
W2. Retrofit 40mm rockwool into the existing dry lining zone	• Better u-value (0.72 W/m2K) • Keeps the existing net lettable area • Improved air tightness (with VCL membrane) • Less energy in use (heating demand)	• -42 Saving	• Changes hygrothermal behaviour of the existing wall which could potentially lead to condensation and long term issues with moisture. • Need to insulate floors and ceilings at interfaces in order to prevent cold bridging. • Need to rebate around existing window frames to provide continuous thermal line. • Doesn't meet the 0.26 u value target in building regs for new or replacement elements.
W3. Retrofit 40mm high performing insulation into the existing dry lining zone	• Better u-value (0.5 W/m2K) • Keeps existing net lettable area. • Improved air tightness • Less energy in use (heating demand)	• +97 Loss	• Changes hygrothermal behaviour of the existing wall which could potentially lead to condensation and long term issues with moisture. • Need to insulate floors and ceilings at interfaces in order to prevent cold bridging. • Need to rebate around existing window frames to provide continuous thermal line. • Doesn't meet the 0.26 u value target in building regs for new or replacement elements.
W4. Retrofit the dry lining zone by 50mm and provide 90mm mineral wool	• Better u-value (0.42 W/m2K) • Improved air tightness • Less energy in use (heating demand)	• -54 Saving	• Changes hygrothermal behaviour of the existing wall which could potentially lead to condensation and long term issues with moisture. • Need to insulate floors and ceilings at interfaces in order to prevent cold bridging. • Need to rebate around existing window frames to provide continuous thermal line. • Doesn't meet the 0.26 u value target in building regs for new or replacement elements. • Reduces net lettable area
W5. Retrofit the dry lining zone and provide 90mm high performing insulation. (or roughly 120mm mineral	• U value compliant with max values allowed in New Part L (0.26W/m2K) • Improved air tightness • Less energy in use (heating demand)	• +292 Loss	• Changes hygrothermal behaviour of the existing wall which could potentially lead to condensation and long term issues with moisture. • Need to insulate floors and ceilings at interfaces in order to prevent cold bridging. • Need to rebate around existing window frames to provide continuous thermal line. • Reduces net lettable area

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New Zealand House

COMPLETED ca. 1963 RMJM

Refurbished 1995 - RMJM

2023 REFURBISHMENT TEAM:

- CLIENT – Crown Estates / NZ Govt
- MAIN CONTRCATOR (PCSA) – Multiplex
- ARCHITECT – Lifschutz Davidson Sandilands
- M&E Consultant – Watkins Payne
- STRUCTURAL ENGINEER– AKT II

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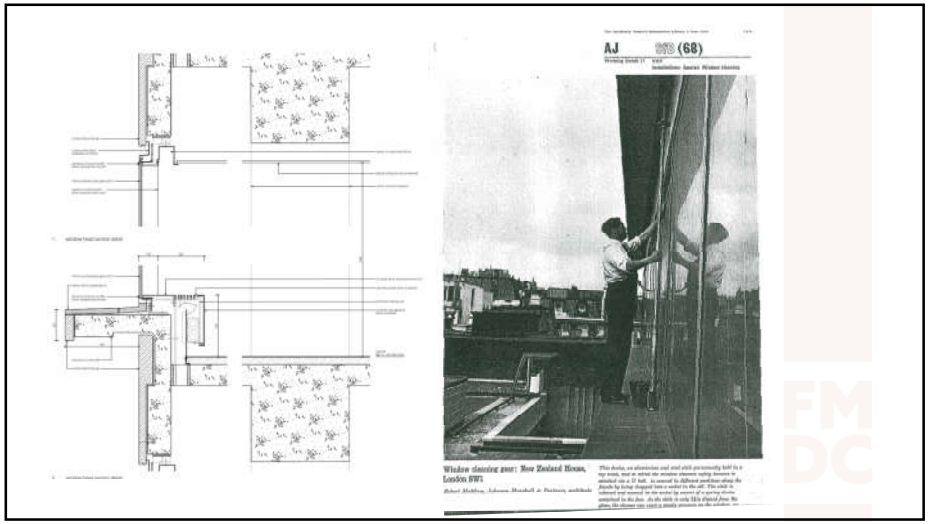

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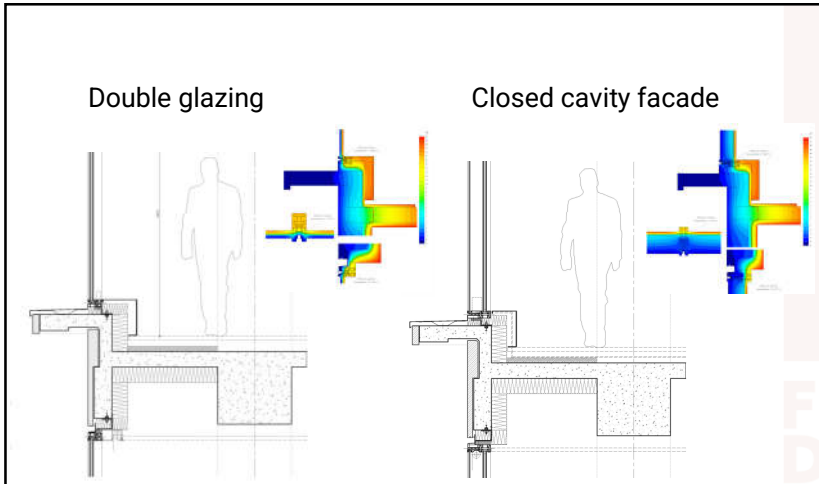

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OPTION	Location	Glazing System	G-Value	Energy model / Plant / Sustainability	Glass specification	Blinds	Appearance of glass/ heritage	Cost (TBC)	Buildability	Maintenance
1	Tower	CCF	<0.2	Good U value performance Good g value performance with blinds down.	Single glazed Laminated outer. Double glazed inner with low e coating only on inside face of cavity.	Electronically operated louvres or blinds within a cavity	Good transparency and light transmission.	£££	2.7m unitised panels installed from slab level (weight to be confirmed to check if possible)	Outer pane replaced from outside. Inner pane replaced from inside.
	Podium	CCF	<0.2					££££	5.4m outer spacing of mullions is a big challenge but possible with a tower crane. Inner spacing can be reduced to 2.7on rear DGUs only	CCF maintenance contract required.
2	Tower	DGU	0.3-0.35	Standard u value performance Standard g-value performance	Double glazed laminated outer and inner. High performance Solar control coating (triple silver)	Could be integrated into base build and benefits calculated for g-value but of limited benefit. More flexibility in blind type and colour	Triple solver coatings could be too tinted reflective from outside.	££	2.7m unitised panels installed from slab edge.	Internally replaced.
	Podium	DGU	0.3-0.35					££	5.4 m unitised panels possible but installed from tower crane. Lack of flexibility for internal cellularisation	
3	Tower	CCF	<0.2	Good U value performance Good g value performance with blinds down.	Single glazed Laminated outer. Double glazed inner with low e coating only on inside face of cavity.	Electronically operated louvres or blinds within a cavity	Good transparency and light transmission.	£££	2.7m unitised panels installed from slab level (weight to be confirmed to check if possible)	Outer pane replaced from outside. Inner pane replaced from inside.
	Podium	DGU	0.3-0.35	Standard u value performance Standard g-value performance	Double glazed laminated outer and inner. High performance Solar control coating (triple silver)	Could be integrated into base build and benefits calculated for g-value but of limited benefit. More flexibility in blind type and colour	Triple solver coatings could be too reflective from outside. Podium and tower may look different.	££	5.4 m unitised panels possible but installed from tower crane. Lack of flexibility for internal cellularisation	Internally replaced.

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Reflectivity of solar coatings

Whole life carbon assessment

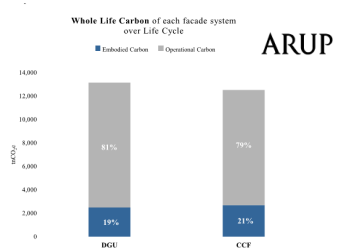

Figure 13 Whole Life Carbon of each facade system over Life Cycle (60 years)

Table 17 Whole Life Carbon calculations for each facade system

	Embodied Carbon over Life Cycle	Operational Carbon over Life Cycle	Whole Life Carbon
DGU	2,488	10,660	**13,149**
CCF	2,684	9,840	**12,525**

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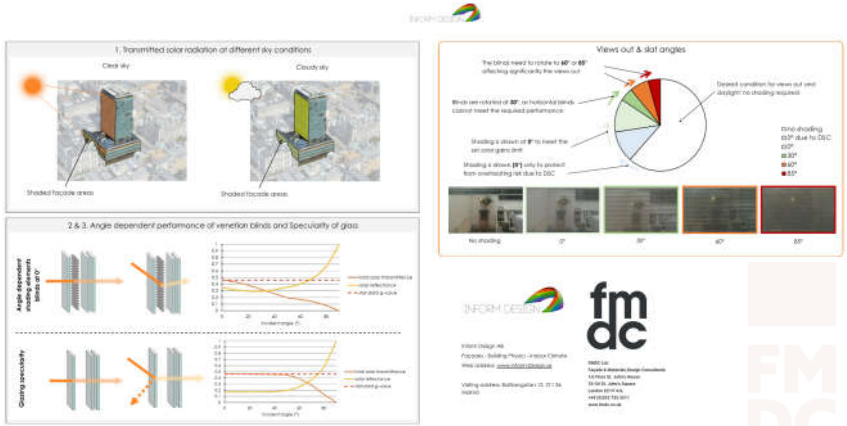

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Woolgate Exchange

Completed ca.2000

ORIGINAL TEAM:

- CLIENT – MEPC
- MAIN CONTRCATOR – Balfour Beatty
- ARCHITECT – Siddell Gibson
- GLAZING DESIGNER
- & INSTALLER – Contano Aluminium
- GLAZING FABRICATOR – Sipral
- GLAZING SYSTEM HOUSE - Schueco
- STONE – Easton Masonry
- PRECAST GREYBACKS - Tarmac
- FAÇADE CONSULTANT - WINTECH

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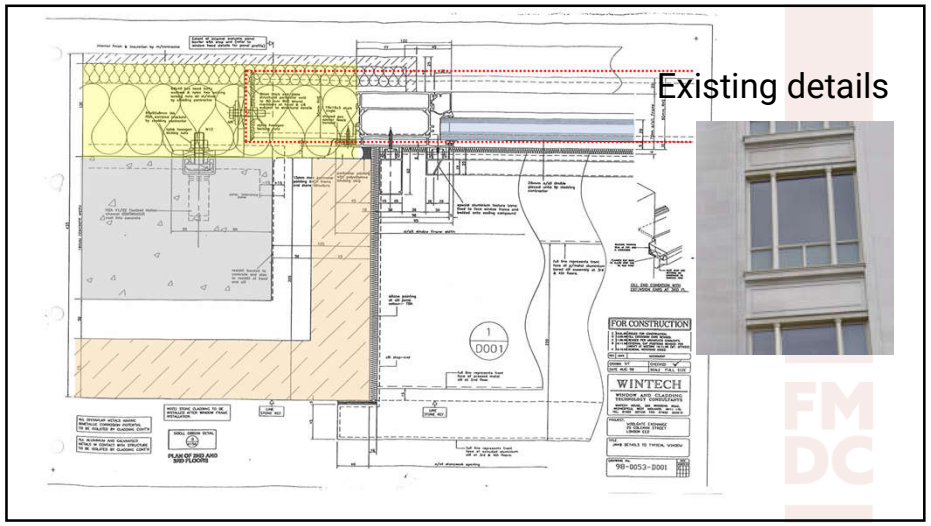

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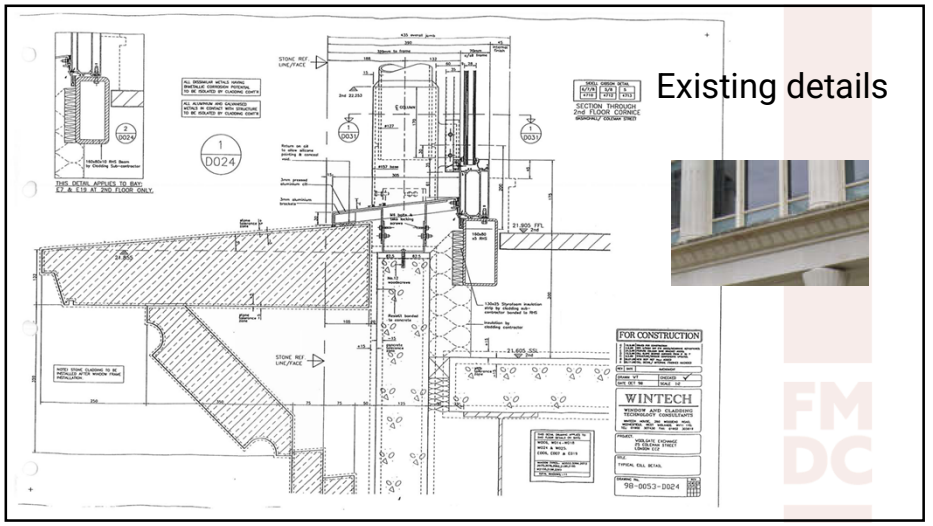

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IMPORTANCE OF EARLY STE INVESTIGATIONS ON THIS PROJECT DUE TO LIMITED / NO AS BUILT INFORMATION

NOTE: BUILDING WAS VACANT FROM STAGE 1

STONE CLADDING

INVESTIGATIONS WERE CARRIED OUT TO:

1. Verify type and depth of existing insulation
2. Verify the thickness of stone cladding and the wall build up behind.
3. Verify the position and the condition of the support bracketry and any structural elements supporting the stone cladding.
4. Metallurgic surveys to verify the type and condition of stone support bracketry.
5. Verify the concrete greyback condition and durability characteristics.
6. Verify the location and type of fire stopping and cavity barrier material within the façade (if any).

CARRIED OUT BY PAYE

PAYE

GLAZING SYSTEMS

INVESTIGATIONS WERE CARRIED OUT TO:

1. Verify expected air tightness performance.
2. Investigate cold bridging through localised thermographic survey.
3. Verify window frame condition and suitability for upgrading with new finishes and glass.
4. Verify the general façade condition in regard to seals/gaskets/membranes etc.
5. Verify the thermal performance of the existing windows and the improvement possible with new glass.
6. Verify solar performance of existing windows.
7. Verify acoustic performance of existing windows.
8. Understand ease of adapting windows on site.
9. Understand ease of respraying windows on site.
10. Understand ease of reglazing windows on site.

CARRIED OUT BY GIG & OAG

OAG GIG PROJECT

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ALL PRIOR TO MAIN CONTRCATOR ENGAGEMENT TO INFORM DESIGN OPTIONS AND PERFORMANCE

- CORE HOLES EXTERNALLY
- LOCAL OPENING UP INTERNALLY
- WATER AND AIR TESTING
- FULL WINDOW STRIP DOWN
- TRIAL SITE REPAINT
- FULL INTERNAL STRIP OUT

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Optioneering

- KEEP EXISTING FRAME AND GLASS (DGU)
- KEEP EXISTING FRAME AND RE-GAS UNITS (DGU)
- KEEP EXISTING FRAME & REPLACE GLASS WITH NEW HIGH PERFORMING DGU.
- KEEP EXISTING FRAME & REPLACE GLASS WITH NEW HIGH PERFORMING TGU.
- REPLACE EXISTING FRAME & GLASS WITH NEW HIGH PERFOMING FRAME & DGU.
- REPLACE EXISTING FRAME & GLASS WITH NEW HIGH PERFORMING FRAME & TGU.

DGU Existing

U-value = 2.1 W/m²K
Spacer = 0.11 W/mK

DGU Improved

U-value = 1.0 W/m²K
Spacer = 0.08 W/mK

TGU

U-value = 0.6 W/m²K
Spacer = 0.08 W/mK

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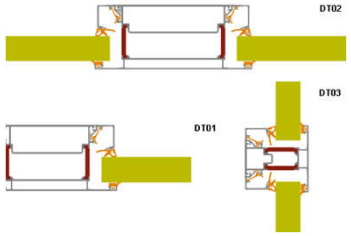
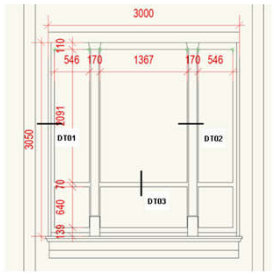
THERMAL PERFORMANCE

STRATEGY WAS TO KEEP INTERNAL LININGS AND NOT IMPROVE EXISTING WALL PERFORMANCE. PERFORMANCE ENHACEMENT THERFORE TO GLAZING ONLY.



TYPE A



TYPE A		U-value [W/m²K]
Existing Framing	DGU - Existing	2.6
	DGU - New	1.7
	TGU - New	1.5
New Framing	DGU - New	1.3
	TGU - New	1.0

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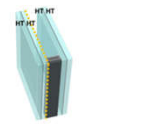
EMBODIED CARBON

ALUMINIUM EMBODIED CARBON EQUIVALENT FACTOR TO NOT EXCEED 4.0kgCO2/kg FOR THE BILLET PRODUCTION (Hydro Reduxa or equivalent).

GLASS VALUES ASSUMED WORST CASE IN DIAGRAM ADJACENT

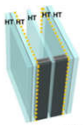
CALCULATIONS BY SWECO, PRE CWCT METHODOLOGY. FMDC PROVIDED ACCURATE MATERIAL VOLUMES.

66.2 / 16 / 66.2



Glass: 60 kg/m2; PVB: 1.6 kg/m2;
GWP_mid-iron: 126.9 kgCO2/m2
GWP_low-iron: 133.7 kgCO2/m2

66.2 / 16 / 4 / 16 / 66.2



Glass: 70 kg/m2; PVB: 1.6 kg/m2;
GWP_mid-iron: 154.1 kgCO2/m2
GWP_low-iron: 162 kgCO2/m2

Material quantities for window framing

Side profile (DT 01)

The table below summarizes the material quantities, on a linear meter, of the side profile.

DT 01	m²/m	mm³/m
Aluminium	0.00065	648.1
EPDM	0.00017	171.6
Polyamide Glass Fibres	0.00026	262.9
PE Foam	0.00086	856.1

Mid mullion profile (DT 02)

The table below summarizes the material quantities, on a linear meter, of the mid mullion profile for large vertical spans.

DT 02	m²/m	mm³/m
Aluminium	0.00271	2712.0
EPDM	0.00034	342.0
Polyamide Glass Fibres	0.00025	248.4
PE Foam	0.00289	2886.2

Mid mullion/transom profile (DT 03)

The table below summarizes the material quantities, on a linear meter, of the mid mullion/transom profile for short horizontal and vertical spans.

DT 03	m²/m	mm³/m
Aluminium	0.00271	2712.0
EPDM	0.00034	342.0
Polyamide Glass Fibres	0.00025	248.4
PE Foam	0.00289	2886.2

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SWECO OPTIMISATION ASSESSMENT

THE ASSESSMENT FOCUSSED ON

1. DGU VS TGU WITH NEW FRAME IN BOTH.
2. RETAINED FRAME VS NEW FRAME WITH NEW DGU IN BOTH.

25 YEAR STUDY PERIOD

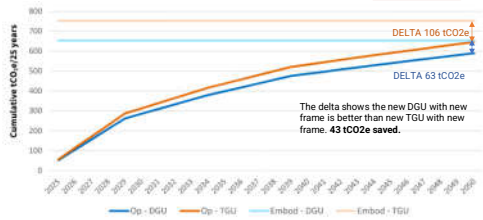
COMPARE EMBODIED CARBON EXPENDED (FLAT LINES) WITH OPERATIONAL CARBON SAVED (UPWARD TRENDING LINES).

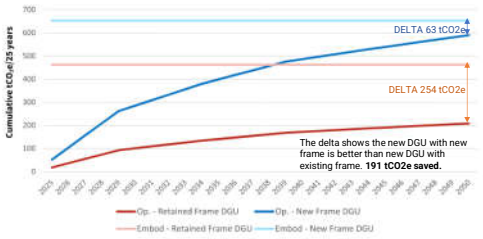
ASSUMES 1 GLASS REPLACEMENT CYCLE.

PAYBACK WOULD BE WHERE BLUE CROSSES BLUE OR RED CROSSES RED, ULTIMATELY THERE IS NO FULL PAYBACK.

THE DELTA BETWEEN OPERATIONAL AND EMBODIED SHOWS THAT NEW FRAME AND NEW GLASS IS BETTER THAN RETAINING THE EXISTING FRAME AND ADDING NEW GLASS

SWECO





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	Potential for improved….						Carbon…
	Thermal Performance	Solar Performance	Acoustic Performance	Safety	Security	Warranty	Initial Embodied Carbon
1. Keep existing frame and glass DGU	No improvement. 2.6W/m2K.	No improvement	No improvement possible (may however not be an issue)	No improvement possible. Risk of broken glass falling from height. Barrier loads would need to be checked.	No improvement possible. Glass build up to be checked against current day security requirements.	No warranty	No impact
2. Keep existing frame and ‘re-gas’ the existing glass DGU	Some improvement for a short time period.	No improvement	No improvement possible (may however not be an issue)	No improvement possible. Risk of broken glass falling from height. Barrier loads would need to be checked.	No improvement possible. Glass build up to be checked against current day security requirements.	No warranty	Impact of re-gassing would need to be assessed (i.e. removal and transported offsite)
3. Keep existing frame and replace glass with new high performing DGU	Good improvement. 1.7W/m2K	New high performance coatings 60/28	High acoustic performance possible with acoustic laminates.	New glass designed to current day safety requirements and best practice.	New glass designed to current day security requirements. Framing system may be weak however.	Individual component warranty, i.e. new DGU warranty possible.	Impact of new double glazing
4. Keep existing frame and replace glass with new high performing TGU	Good improvement. 1.5W/m2K	New high performance coatings (two coatings required with TGU)	High acoustic performance possible with acoustic laminates.	New glass designed to current day safety requirements and best practice.	New glass designed to current day security requirements. Framing system may be weak however.	Individual component warranty, i.e. new TGU warranty possible.	Impact of new triple glazing
5. Replace existing frame with new high performance frame and replace glass with new high performance DGU	Better improvement 1.3W/M2k (could be improved further if architecture changed).	New high performance coatings 60/28	High acoustic performance possible with acoustic laminates.	New glass designed to current day safety requirements and best practice.	New glass designed to current day security requirements. Framing system could be enhanced if required.	Full system warranty	Impact of new double glazing and framing system
6. Replace existing frame with new high performance frame and replace glass with new high performance TGU	Best improvement. 1.0W/m2K. (could be improved further if architecture changed).	New high performance coatings (two coatings required with TGU)	High acoustic performance possible with acoustic laminates.	New glass designed to current day safety requirements and best practice.	New glass designed to current day security requirements. Framing system could be enhanced if required.	Full system warranty.	Impact of new triple glazing and framing system

	Carbon…				Other Performance Targets…		Cost Considerations…	
	Whole Life Embodied Carbon (say 50 years)	Operational Carbon (assuming heating driven)	Whole Life Carbon	Ongoing Maintenance	Part L Compliance	Other Aspirational Targets (BREEAM/ Nabers/EPC etc.)	Upfront Financial Cost	Long Term Financial Cost
1. Keep existing frame and glass DGU	Units will eventually fail (fog) and need to be changed. Worst case scenario is three changes potentially required. Additional future work to framing may be required.	Sweco to advise. Likely upfront operational carbon is more due to poor performance. System design impact perhaps.	Sweco to advise impact of improving glazing at later stages.	Sporadic failure (fogging) of glass units may require ongoing replacement. Risk of 'Patchwork' appearance and performance. Warranty variance. Frame may need future maintenance.	'Consequential Improvements' may dictate an improvement in u-value is necessary.	Sweco to advise. Likely to impact what is achievable quite considerably.	Limited cost (respray framing and adaptation). May have a larger upfront carbon offset to consider.	May be more costly if 3 no. replacements required. Framing may need further maintenance at some point.
2. Keep existing frame and ‘re-gas’ the existing glass DGU	Units will eventually fail (fog) and need to be changed. Worst case scenario is three changes potentially required. Additional future work to framing may be required.	Likely upfront operational carbon is more due to relatively poor performance. System design impact perhaps.	Sweco to advise impact of improving glazing at later stages.	Sporadic failure (fogging) of glass units may require ongoing replacement. Risk of 'Patchwork' appearance and performance. Warranty variance. Frame may need future maintenance.	'Consequential Improvements' may dictate an improvement in u-value is necessary	Likely to impact what is achievable quite considerably.	Cost of re-gassing the units to be considered. Otherwise limited cost. May have a larger upfront carbon offset to consider.	May be more costly if 3 no. replacements required. Framing may need further maintenance at some point.
3. Keep existing frame and replace glass with new high performing DGU	12-15 year warranty on new unit. 25 year service life. Two changes potentially required. Additional future work to framing may be required.	Sweco to advise. Reduced up front operational carbon due to improvement.	FMDC can advise the performance drop off after say 12-15 years. Sweco could perhaps advise the impact of this on operation carbon.	Frame may need future maintenance.	Minimum targets within Part L could be achieved.	Sweco to advise.	Cost of new DGU	Framing may need further maintenance at some point.
4. Keep existing frame and replace glass with new high performing TGU	12-15 year warranty on new unit. 25 year service life. Two changes potentially required. Additional future work to framing may be required.	Sweco to advise. Improved again.	FMDC can advise the performance drop off after say 12-15 years. Sweco could perhaps advise the impact of this on operation carbon.	Frame may need future maintenance.	Minimum targets within Part L could be achieved.	Sweco to advise.	Cost of new TGU, more expensive than DGU.	Framing may need further maintenance at some point.
5. Replace existing frame with new high performance frame and replace glass with new high performance DGU	12-15 year warranty on new unit. 25 year service life. Two changes potentially required. Minimal future work to framing may be required.	Sweco to advise. Better	FMDC can advise the performance drop off after say 12-15 years. Sweco could perhaps advise the impact of this on operation carbon.	Limited maintenance required other than regular cleaning.	Minimum targets within Part L could be achieved.	Sweco to advise.	Cost of new frame and glazing, logistics for install etc.	Limited impact long term.
6. Replace existing frame with new high performance frame and replace glass with new high performance TGU	12-15 year warranty on new unit. 25 year service life. Two changes potentially required. Minimal future work to framing may be required.	Sweco to advise. Best	FMDC can advise the performance drop off after say 12-15 years. Sweco could perhaps advise the impact of this on operation carbon.	Limited maintenance required other than regular cleaning.	Minimum targets within Part L could be achieved.	Sweco to advise.	Cost of new frame and glazing, logistics for install etc.	Limited impact long term.

Preferred Option

OTHER DECISION MAKING CRTIERIA

ULTIMATELY THE DECISION TO RETAIN THE FRAME AND ADD NEW DGU WAS PROGRESSED

MATRIX OF OPTIONS AND DRIVERS

KEY DECISIONS AROUND

- UPFRONT EMBODIED CARBON.
- LOGISTIC IMPACT OF REMOVING AND INSTALLTING NEW FRAMES.
- REMOVAL OF EXISTING FINISHES REQUIRED AND CARBON IMPACT OF DOING SO.
- PROGRAMME IMPACT.
- FINANCIAL COST IMPACT.

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3 different refurbishment projects:

- Every project is different with different influencing factors and drivers
- Knowledge of different materials and historic build methods is fundamental.
- Collaboration with Sustainability and M&E colleagues is paramount.

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