Case Study

July 2012

European Liability Insurance Organisation Schemes

3. Double-Skin Curtain Walls/Façades

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3.1 Introduction to the technology

Double skin curtain walls (or façades) consist of two glazed skins placed in such a way that air flows in the intermediate cavity. The ventilation of the cavity can be natural or mechanical. The origin and destination of the air within the cavity can differ depending on climatic conditions, building use, occupational hours and the overall HVAC strategy.

Adjustable openings are built into both the outer and inner skins of the cavity, and by controlling the openings to vary the direction of air flow, a double skin façade can be used to heat or to cool the building. In winter, air is allowed in at the bottom of the cavity and is vented into the building, causing free heat to be 'pushed' into the building. In summer, air is allowed in at the bottom of the cavity and is vented to atmosphere at the top, creating a solar chimney effect which can then 'pull' cooler air through the building from its far side. In both cases, an automatic control system is normally required to ensure the correct sequencing and adjustment of the openings and vents.

The glass skins can each be single- or double- glazed, with a distance between them from 20cm to 2m. To protect against overheating, solar shading devices can be placed either inside the cavity or on the outer face of the building.

Even without the passive heating and cooling effects achieved by the variable air flow, this glazing configuration has improved insulation properties compared to a conventional glazed façade.

The most well-known buildings in the UK which have double skin façades are 30 St Mary Axe, London (also known as 'The Gherkin') and 1 Angel Square, Manchester (headquarters of The Cooperative Group). Both of these buildings claim significant environmental performance due to their double skin façades.

30 St Mary Axe – showing triangular openings in the outer skin

1 Angel Square – showing the inner skin, with the outer skin under construction at the lower part of the

3.2 Available types of this technology

Double skin façades are not products which can be bought 'off the shelf'; they are engineered systems which are assembled on site from standard glazing, curtain walling and M&E components. As a result there is no standard typology for double skin façades, but they can usefully be categorised using three characteristics, as follows:

Design intent:

a) Intended **to heat** the internal environment by exploiting passive solar gain
b) Intended **to cool**, either
   - the internal envirionment (via a solar chimney effect), or
   - just the façade, by venting excess summertime heat
c) Intended **to both heat and cool** depending on the season

Ventilation strategy within the cavity:

a) Natural ventilation (convection only)
b) Mechanical ventilation (fan-assisted)

Shading type

a) In-cavity shading
b) External shading

In all cases the successful performance of a façade system requires there to be a dedicated control strategy.

At its simplest, the control strategy might consist of straightforward manual operation of the openings and shading devices. At its most complex, the strategy could be a highly building-integrated energy management system which controls the openings, fan speeds and shading devices according to internal and external conditions (as well as those within the cavity).

A multitude of heating and cooling strategies can be implemented using the same façade under central control, by automatically adjusting both the internal and external openings, other vents, fan speed and direction, and the operation of shading devices. By virtue of the fact that double skin façades are engineered systems which are assembled on site, their control systems are likely to be highly bespoke.

3.3 Strengths, weaknesses, opportunities and threats

This section outlines a discussion of the key drivers affecting double skin façades.

Strengths

- Can provide 'free' heat and/or cooling.
- Enables natural ventilation to be implemented in windy environments (including high-rise buildings).
- Achieves improved insulation values.
- Improves thermal comfort by buffering the internal glass temperature.
- Good acoustic properties in urban environments.
- Can have very simple, manual controls (although more normally automatic).

Weaknesses

- Not a standard 'product' per se, so very dependent upon the designer's skills and the installation quality.
- Similar insulative values may be obtained using conventional high performance, low-emissivity windows.
- The cavity results in a decrease in usable floor space.
- Depending on the strategy for ventilating the cavity, there may be problems with condensation, dirt or outside noise.
- The construction of a second skin may significantly increase materials, design and installation costs.
- Building energy modelling is inherently more difficult because of the complex heat transfer characteristics of the cavity.

Opportunities

- General trend towards higher rise buildings, with associated wind and temperature management issues.
- Rising energy costs.
- Predilection among building owners for 'passive' systems and natural ventilation.
- Extremely flexible; every installation is effectively bespoke, so building forms can be as simple or as complex as the client wishes.

Threats

- Rise of rival technologies (natural ventilation, energy-efficient mechanical cooling).
- Construction complexity.
- Recession – rival technologies may be more scalable, and more easily skilled-up, than double skin façades.
- Increasing wind speed as a result of climate change.

3.4 Building pathology, defects, and what can go wrong

3.4.1 Invitations to complete questionnaire

An invitation to complete the online version of the Elios II questionnaire was sent to 374 individuals in the following industry sectors:

TABLE 3.1 – Invitations to complete questionnaire

Sector	***Number sent***
Insurance	64
Certification Bodies	10
Accreditation Organisations	4
Builders/Installers	55
Manufacturers	74
Trade Associations	27
Professional Institutes	19
Architects	14
Quantity Surveyors	2
Other	4
Building Inspection Services	13
Government Organisation	22
Housing Associations/Commissioner	16
Consultancies	15
Merchant/retailer	5
Unknown	30
Total	374

In total 70 respondents completed some or all of the questionnaire. This is an 18% response rate.

3.4.2 Responses received

At the closing date of 1st October 2012, 7 responses had been received which related specifically to paper-based insulation. This is 9% of the received questionnaires. The industry sectors of the respondents were as follows:

TABLE 3.2 – Responses

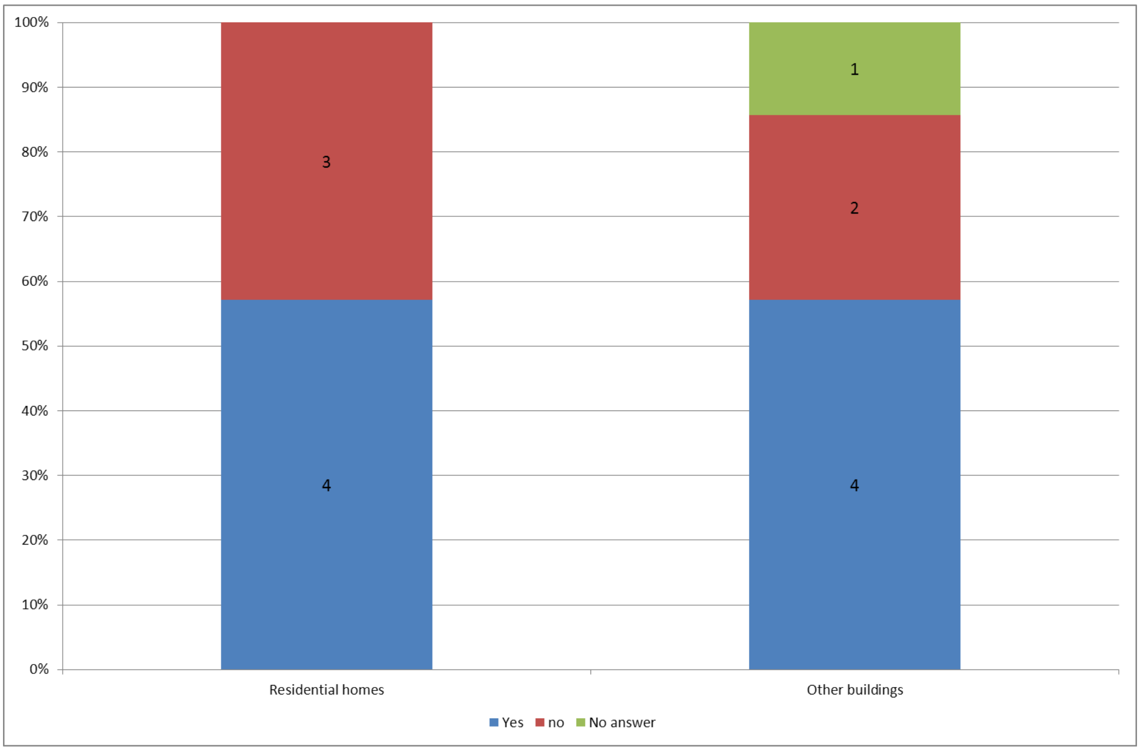
Sector	*Responses received*
Government organisation	2
Architectural practice	0
Housing organisation	0
Manufacturer	1
Retailer/merchant	0
Construction company	1
Installer	0
Building inspection service	2
Certification organisation	3
Insurance company	2
Trade association	0
Professional institution	1
Other (please specify)	0
Business in more than one	3
Total	15

Note that a respondent might have classified their business in more than one sector.

The respondents collectively claimed to have data relating to 172 installations of the technology, of which 57 (33%) were said to have experienced failures or defects. 150 (with 50 having defects) were reported by one respondent.

The following graphs and charts only relate to the people who responded about this technology.

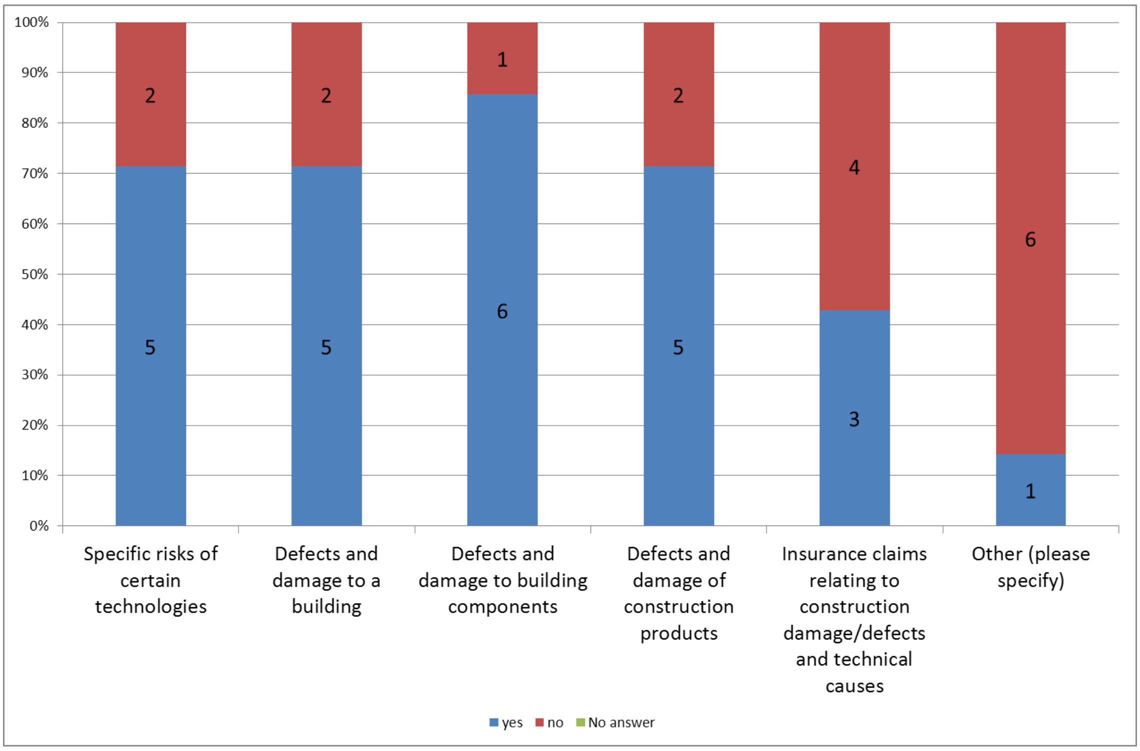
CHART 3.3
Question asked – *"Does your organisation collect or collate its own data on these types of buildings?"*



This chart shows the number of reporting organisations that collect data on each type of property. This is only for this eco-technology. Organisations may collect data on more than one type of property.

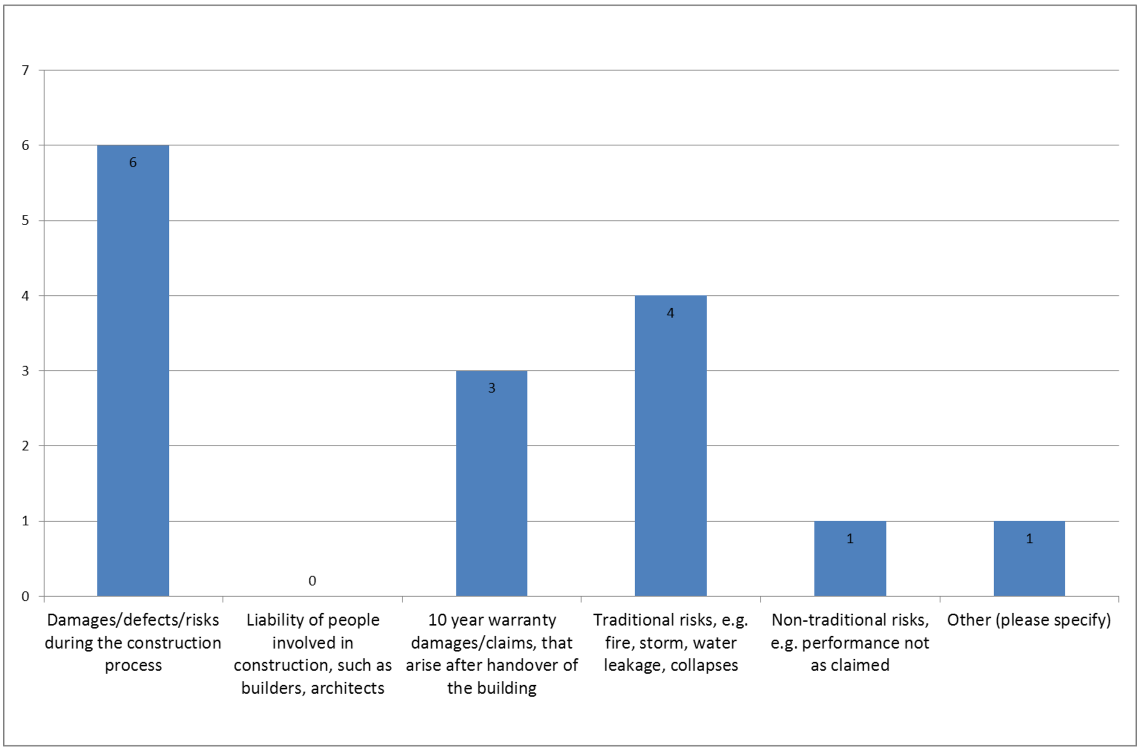
CHART 3.4

Question asked –*"Does your organisation collect its own data on these issues (please tick all that apply)?"*



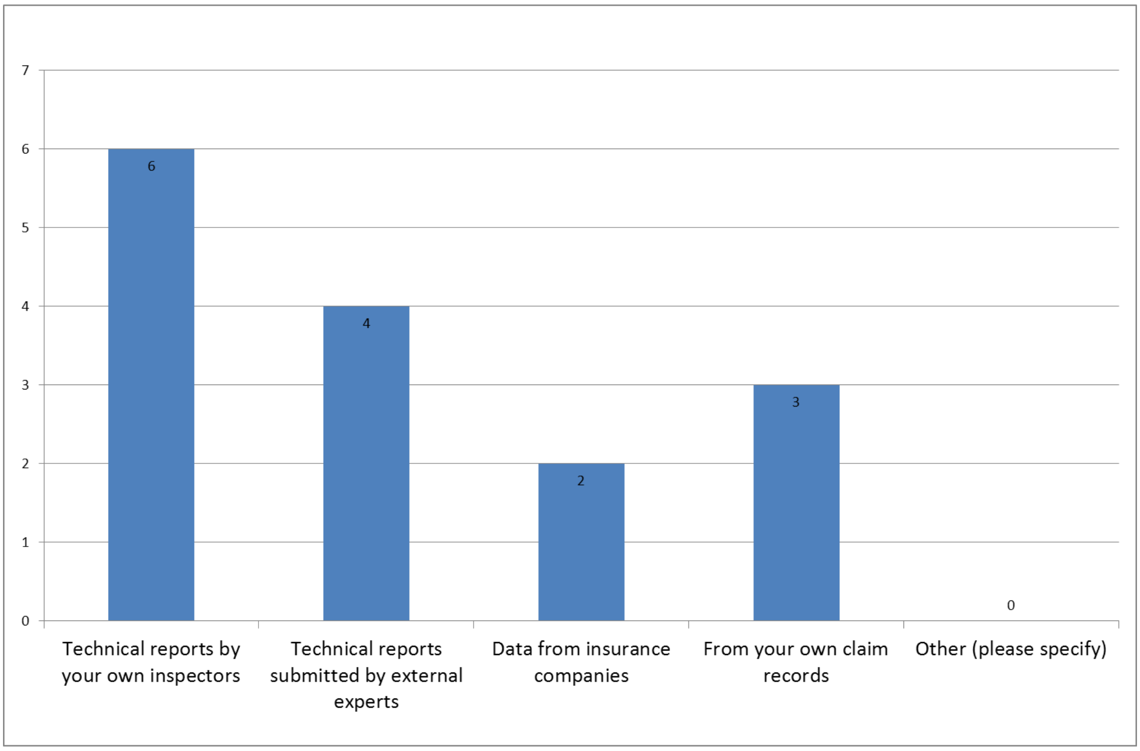
This chart shows the various reasons that the reporting organisations collect data, and the number of organisations that gave each reason. This is only for this eco-technology, and not for all 10 technologies. Organisations may collect data for more than one reason.

CHART 3.5
Question asked – *"What kind of damages/defects do the data refer to (please tick all that apply)?"*



This chart shows the number of organisations that reported each kind of damage on which they collect data. Each column represents a different type of damage. This is only for this specific eco-technology, not overall. Organisations may collect data for more than one reason.

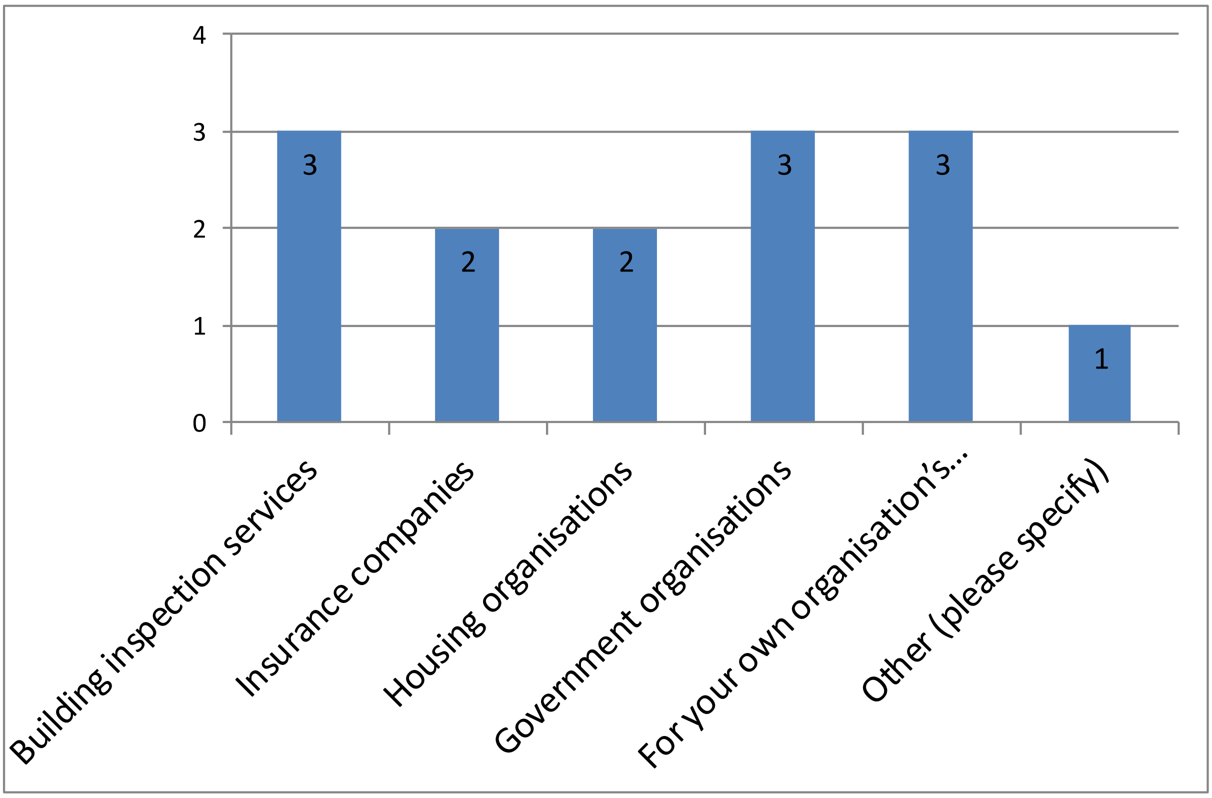
CHART 3.6
Question asked – *"How do you collect the data (please tick all that apply) ?"*



This chart shows, for the number of organisations that reported for this eco-technology, the type of organisation for which the data is collected. Organisations may collect data for more than one reason.

Note that respondents may collect data for more than one organisation.

CHART 3.7
Question asked "*For whom do you collect the data (please tick all that apply)?*"



This chart shows the number and type of organisations that reported that they collect data about this eco-technology. Organisations may collect data for more than one type of organisation.

3.4.3 Summary of responses about databases

About their database:

- 4 have a database, 1 did not respond;
- 2 provided a date when data collection started – 1970 and 2007;
- 4 carry out statistical analysis of the data;

About data publication:

- 4 make data available on the web;
- 3 in newsletters;
- 3 in other publications;

About the availability of data, of these 6 respondents:

- 4 publish summary data only;
- 2 publish raw data in any form;
- 1 publish raw data, even anonymously;

3 comments were passed, as follows:

- *"Confidential to ourselves and the providers - used to inform various services and policy"*
- *"Publically to house builders not general public on defects"*
- "Only the results of research work."

Finally, note that this question was answered in general about all 10 eco-technologies and may not apply to the specific technology.

3.4.4 Reasons for failures and defects

The reported reasons for the failures and defects were as follows:

TABLE 3.8

Reason for failure/defect	Number	% of total
Requirement management		
Change in client's requirements	2	1.2%
Misunderstanding of the effectiveness of the technology	7	4.1%
Poor project management	4	2.3%
Inaccurate engineering or architectural data	4	2.3%
Delivery		
Late delivery	2	1.2%
Storage issues	0	0.0%
Awkward packaging	0	0.0%
Poor transport of product	0	0.0%
Installation		
Incorrect design for installation	7	4.1%
Incorrect installation documentation	0	0.0%
Failure in installation	12	7.0%
Commissioning failure	0	0.0%
Operational failure		
Product failure once installed	9	5.2%
Incorrect user documentation	6	3.5%
Misuse of product by end-user	0	0.0%
Performance not as claimed	4	2.3%
Other		
No other reasons were given for failure		
Total		

Note that an installation may have had more than one reason to fail.

3.4.5 Failures/defects commentary

The respondents offered the following general comments and suggestions on the ways in which the failures and defects might be avoided in future:

TABLE 3.9

Reason for failure/defect	Commentary
Requirement management	
Change in client's requirements	
Misunderstanding of the effectiveness of the technology	Better understanding of the system physics (ed: We assumed this means that designers and architects do not fully understand the technology at a fundamental level. No detail on these lessons has been provided.)
Poor project management	
Inaccurate engineering or architectural data	
Delivery	
Late delivery	
Storage issues	
Awkward packaging	
Poor transport of product	

Installation	
Incorrect design for installation	Respecting the project specifications.
Incorrect installation documentation	
Failure in installation	Control documents by independent body
Commissioning failure	Exact supervisor
Operational failure	
Product failure once installed	Appropriate choice of materials
Incorrect user documentation	
Misuse of product by end-user	Control documents by independent body. Better understanding of the system physics (Ed, again assumed this is by the user; no detail was provided)
Performance not as claimed	Exact supervisor Better understanding of the system physics
Other (specified)	

Two other general comments were made

- *"All the above"*
- *"Speak with technical side of the business"*

3.4.6 Key findings

In summary:

- Unsurprisingly, given the nature of this technology, the installation phase is seen as key to avoiding failures.
- Very little opinion was offered on ways to avoid failures in future.

Lessons:

- Improve understanding and manage expectations at all stages of the product lifecycle (designer, installer, end-user)