

SCOTTISH ASSOCIATION OF UNIVERSITY DIRECTORS OF ESTATES

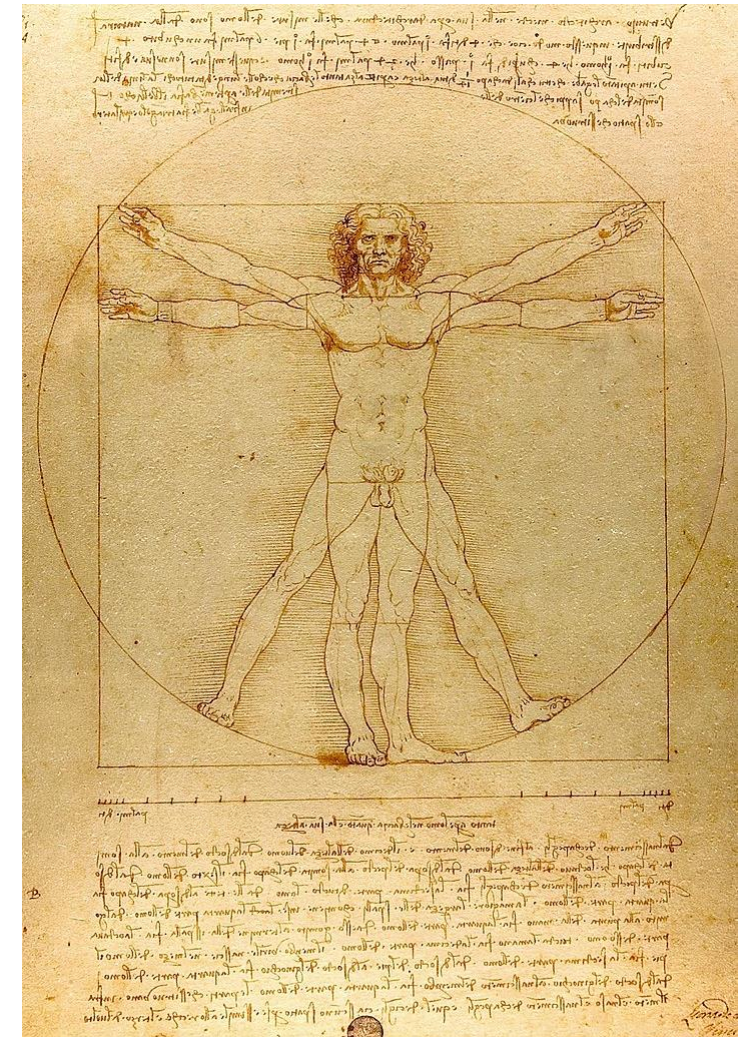
September 2018

RESTORING CONFIDENCE: THE NEED FOR A FOCUS ON QUALITY

Prof. John Cole CBE RIBA



- MARCUS VITRUVIUS POLLIO in 'De Architectura' written between 30 and 15 BC defined building quality as requiring the three characteristics of; UTILITAS, FIRMITAS et VENUSTAS
- FUNCTIONALITY, DURABILITY and DELIGHT
- Buildings are built to provide long-term functionality and delight to users but the achievement of both these characteristics is ultimately compromised if the build quality does not deliver the required durability



Vitruvian Man
Leonardo Da Vinci c1490

MARCUS VITRUVIUS POLLIO writing in 'De Architectura'

'Our workmen, in their hurry to finish, devote themselves only to the facings of the walls, setting them upright but filling the space between with a lot of broken stones and mortar thrown in anyhow.'

'Leave a cavity behind the [wall] facings, and on the inside build walls two feet thick, made of red stone or burnt brick or lava in courses, and then bind them to the fronts by means of iron clamps and lead. ...the beds and builds, all settling equally and bonded at the joints, will not let the work bulge out, nor allow the fall of the face walls which have been tightly fastened together'.

'One who in accordance with these notes will take pains in selecting his method of construction, may count upon having something that will last'.

The latter part of this presentation will indicate that large parts of our Construction Industry in the 21st century have forgotten this first century BC lesson in relation to building for durability.

.



UNIVERSITIES AS PATRONS OF DESIGN EXCELLENCE

- Universities over many centuries as creators and bastions of knowledge
- Also patrons of design excellence and high build-quality to provide the necessary enduring facilities for the development, protection and transfer of that knowledge from generation to generation. Still viewed by many as maintaining that wider duty of patronage of design.
- The best architects, the best materials, the best workmanship
- This has produced many buildings that have helped shape civilisation and have become permanent cultural icons for the world
- Durability in these buildings has been planned for and delivered by their conceivers thus providing functional longevity and societal delight through creating and enhancing the built environment over many centuries



UNIVERSITY OF BOLOGNA FOUNDED 1088
THE ARCHIGINASSIO 1563 BY ANTONIO MORANDI STILL SERVING AS ADMINISTRATIVE HQ OF THE UNIVERSITY
AND MUNICIPAL LIBRARY



UNIVERSITY OF BOLOGNA
ARCHIGINASSIO



OXFORD UNIVERSITY FOUNDED 1096

QUEEN'S COLLEGE OXFORD BY CHRISTOPHER WREN and NICHOLAS HAWKSMOOR 1693 -1737



RADCLIFFE CAMERA OXFORD BY JAMES GIBBS 1737-49



CAMBRIDGE UNIVERSITY FOUNDED 1209
EMMANUEL COLLEGE CAMBRIDGE BY CHRISTOPHER WREN 1663



ST. ANDREW'S UNIVERSITY FOUNDED 1413
ST. SALVATOR'S CHAPEL 1450



GLASGOW UNIVERSITY FOUNDED 1451
GILMOREHILL CAMPUS BY SIR GEORGE GILBERT SCOTT AND JOHN OLDRID SCOTT 1867 -1891
MEMORIAL CHALPEL BY SIR JOHN JAMES BURNET 1923-29.



GLASGOW UNIVERSITY MAIN BUILDINGS



ABERDEEN UNIVERSITY FOUNDED 1495
KING'S COLLEGE CHAPEL POSSIBLY BY ALEXANDER GALLOWAY RECTOR OF UNIVERSITY 1509



EDINBURGH UNIVERSITY FOUNDED 1583

OLD COLLEGE EDINBURGH BY ROBERT ADAM / WILLIAM PLAYFAIR / ROBERT ANDERSON 1789 -1877



PLAYFAIR LIBRARY AND SURGEONS' MUSEUM
EDINBURGH UNIVERSITY



HELSINKI TECHNOLOGICAL UNIVERSITY BY ALVAR AALTO 1950-60



ST.ANDREW'S UNIVERSITY

MELVILLE HALL STUDENT ACCOMMODATION BY JAMES STIRLING 1968

Category A Listing in 2011.

Ranked 12th in Prospect magazine's 2005 list of the top 100 Scottish buildings of the last 50 years

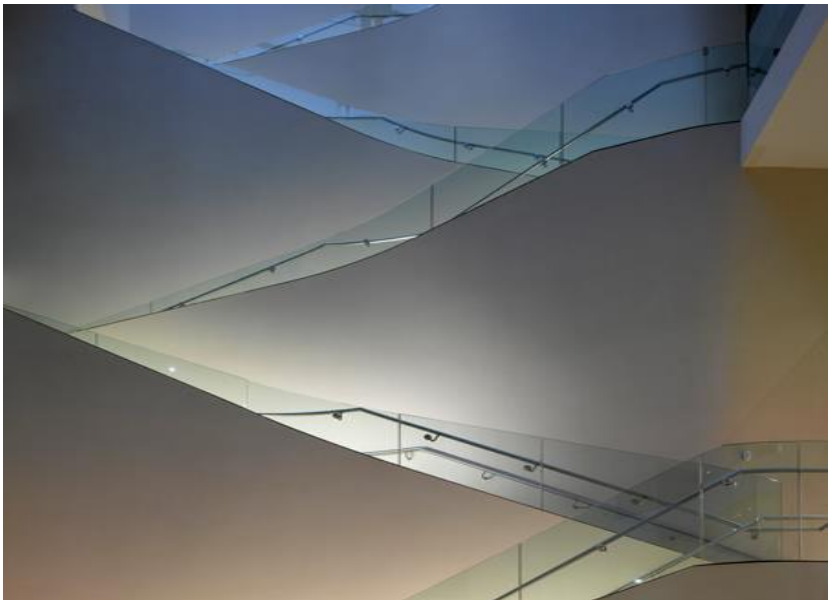
However reported as requiring extensive remedial repairs over several decades

MAINTAINING THE TRADITION OF UNIVERSITIES AS PATRONS OF DESIGN EXCELLENCE

Six UK University Buildings have won or have been one of six buildings shortlisted each year (a total of 132) since the inauguration in 1996 of the Stirling Prize, recognised as one of the most prestigious architectural awards in the world.



SALFORD UNIVERSITY
CENTENARY BUILDING BY HODDER ASSOCIATES 1996 - INAUGURAL WINNER OF STIRLING PRIZE



OXFORD UNIVERSITY
EXTENSION TO ASHMOLEAN
MUSEUM BY RICK MAHER
STIRLING PRIZE SHORTLIST 2010



CAMBRIDGE UNIVERSITY
SAINSBURY LABORATORY BY STANTON WILLIAMS ARCHITECTS - STIRLING PRIZE WINNER 2012



SAINSBURY LABORATORY CAMBRIDGE





SAINSBURY LABORATORY CAMBRIDGE



OXFORD UNIVERSITY
THE BLAVATNIK SCHOOL OF GOVERNMENT BY HERZOG & DE MEURON
STIRLING PRIZE SHORTLIST 2016



THE BLAVATNIK SCHOOL OF GOVERNMENT OXFORD



UNIVERSITY OF ROEHAMPTON
CHADWICK HALL BY HENLEY HALEBROWN
STIRLING PRIZE SHORTLIST 2018
(winner not yet due to be announced)



OXFORD UNIVERSITY
THE SULTAN NAZRIN SHAH CENTRE BY NIAL MCLAUGHLIN ARCHITECTS
STIRLING PRIZE SHORTLIST 2018 (winner not yet due to be announced)

The RIBA International Prize

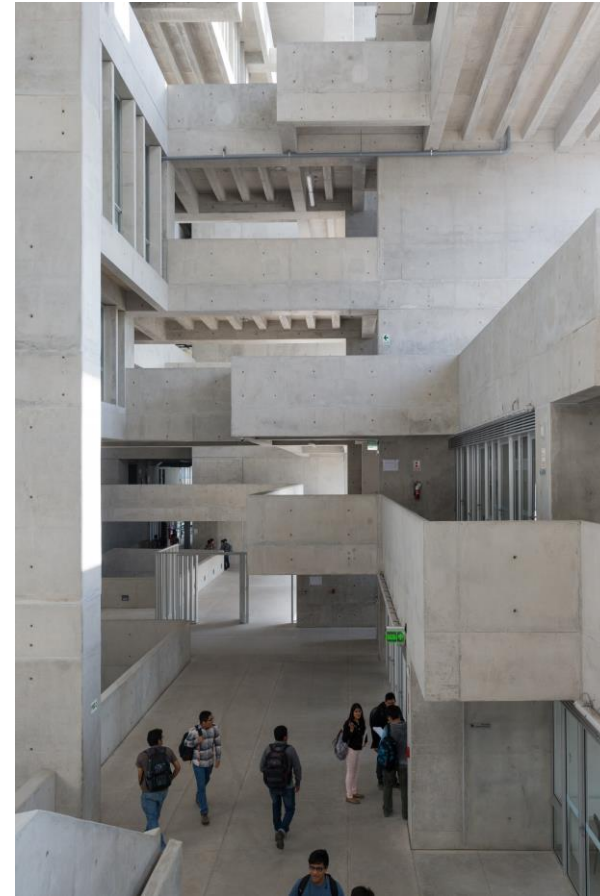
Awarded to a building which exemplifies design excellence, architectural ambition and delivers meaningful social impact. The RIBA International Prize winner and RIBA Awards for International Excellence winners will be selected from a selection of the world's best new buildings compiled from the entries to the awards.

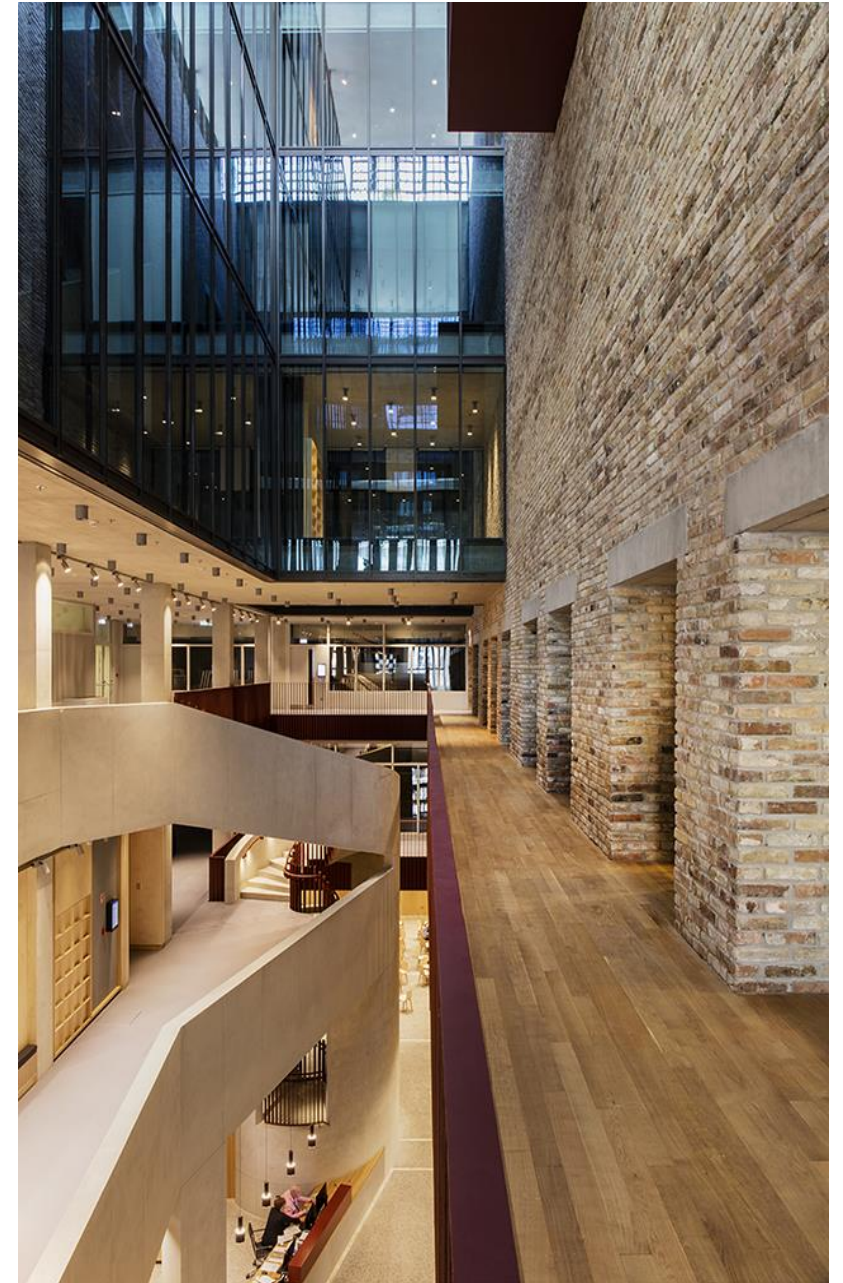
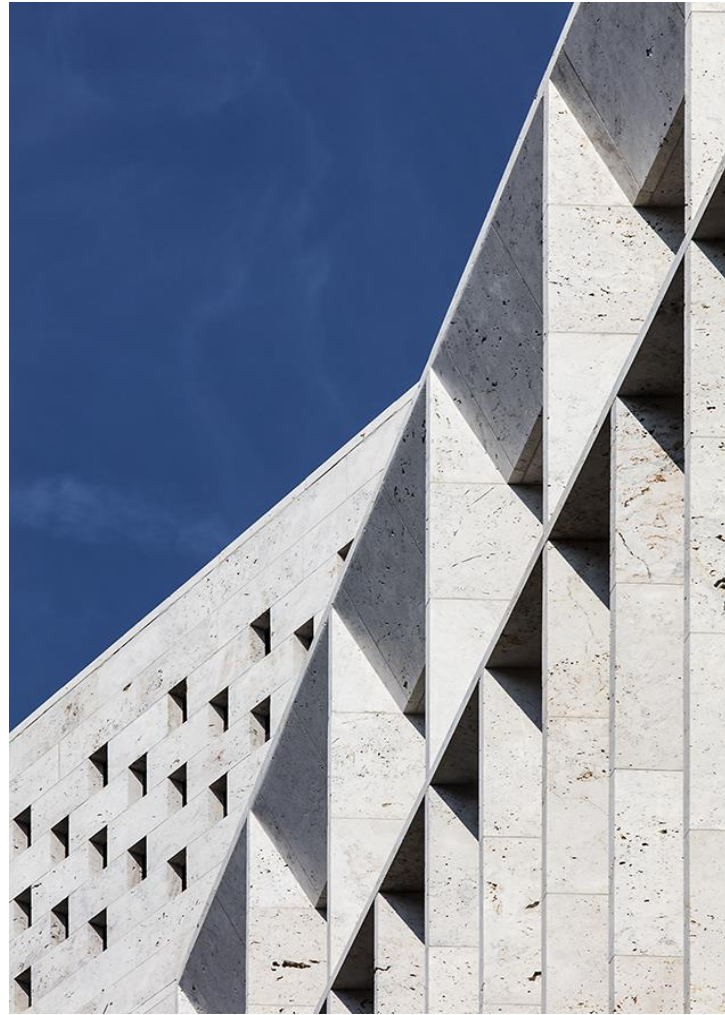
The Prize, awarded every two years, brings international attention to the most inspirational and significant new buildings across the globe but also to a range of the industry's leading talents.



UTEC UNIVERSITY OF ENGINEERING AND TECHNOLOGY LIMA
NEW ENGINEERING CAMPUS BY GRAFTON ARCHITECTS 2015

WINNER OF 2016 RIBA INTERNATIONAL PRIZE

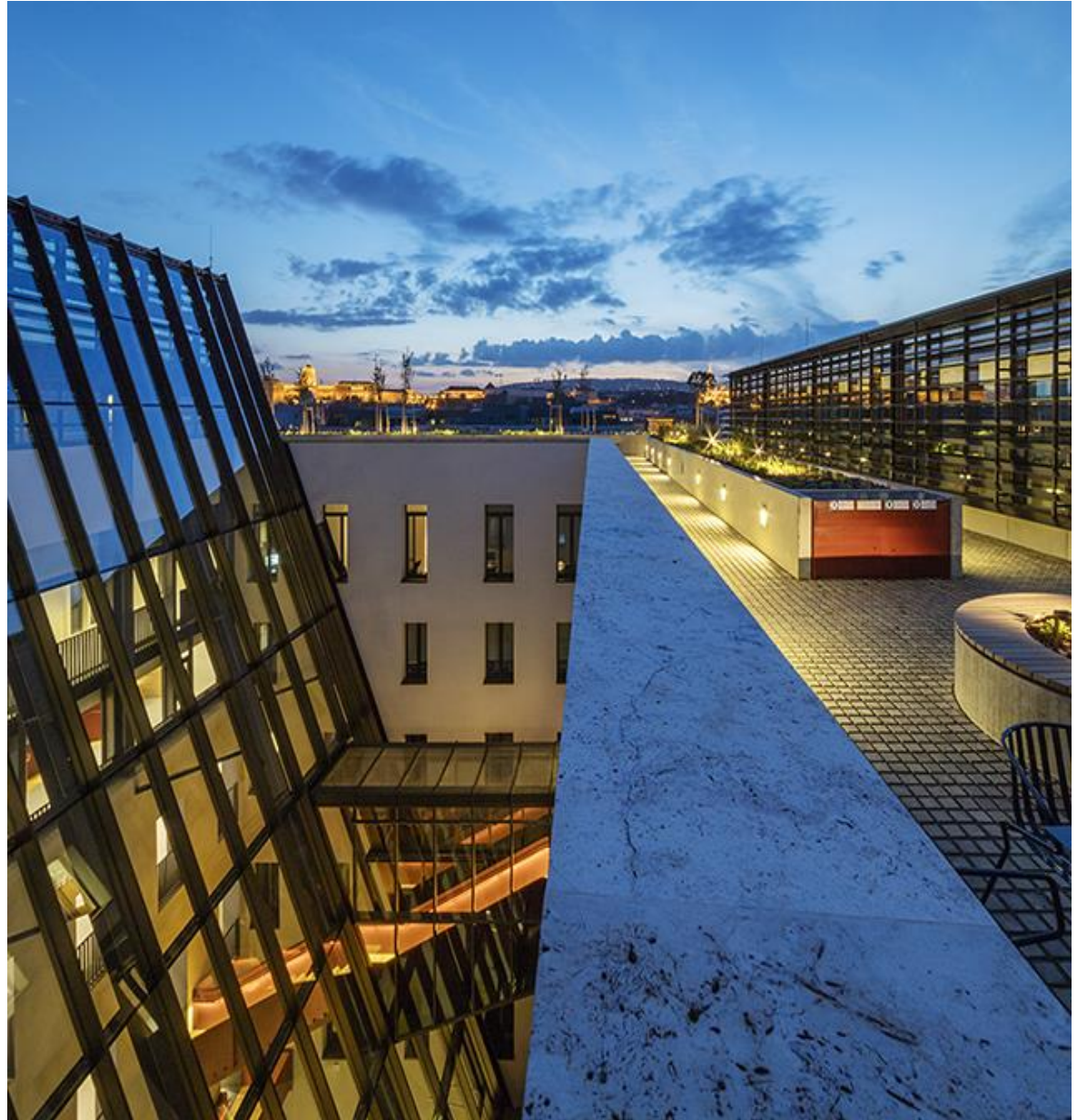




CENTRAL EUROPEAN UNIVERSITY BUDAPEST
FIRST PHASE OF NEW CAMPUS BY O'DONNELL AND TWOMEY 2016
SHORT-LISTED RIBA 2018 INTERNATIONAL PRIZE (not yet announced)



Central European University Budapest





Will the build quality of the best university buildings of today enable them to endure as well as those buildings of the past to become in their turn the cultural icons of tomorrow?

In addition to DELIGHT and FUNCTIONALITY are we adequately ensuring Vitruvius's third requirement of quality i.e. DURABILITY?



EVIDENCE OF SIGNIFICANT CONCERN FOR GENERAL BUILD QUALITY IN UK

There has been an increasing lack of confidence in the build-quality and safety of buildings delivered by the U.K. Construction Industry over recent years

Is this a reflection of many with a focus on cost and time and too few with a focus on quality?

With fundamental changes in project and design leadership roles, we need to ask who is looking after the quality OF CONSTRUCTION? Unfortunately it is often no longer the role of the designers.

What control would Wren, Hawksmoor, Adam and Playfair be allowed ON SITE in their pursuit of quality on the average D & B public sector project today?

Designers increasingly being relegated to concepts, appearance and aesthetics losing control of the detail as actually constructed but we all know;

‘GOD IS IN THE DETAIL’ (Mies van der Rohe)

MAJOR STRUCTURAL DEFECTS FOUND AT 17 EDINBURGH SCHOOLS



DAMNING
REPORT
IDENTIFIES
MAJOR
DEFECTS IN
£20M DUMFRIES
LEISURE
CENTRE



More than half of new-build homes in England 'have major faults'

Shelter survey finds 51% of owners of recent new builds experience problems including construction, fittings and utilities



Defects found at 72 more Scottish school buildings

🕒 13 April 2017 | [Scotland politics](#) | [Comment](#)

[f](#) [t](#) [m](#) [✉](#) [Share](#)



BBC Headline April 2017

NEWS / LOCAL

5 Aberdeenshire schools facing repairs over wall 'defects'

by Adele Merson ⌚ 23/06/2017, 8:45 am



Four of the affected schools

Headline June 2017

Structural defects in schools 'may exist in other public buildings'



Concerns over safety were raised following the collapse of a wall at Oxbgangs Primary in Edinburgh last January
TIMES PHOTOGRAPHER JAMES GLOSSOP

The serious structural defects identified in Scotland's schools may not be confined to the education sector, an architectural expert has claimed.

**Headline from
'The Times' April 2017**

EXCLUSIVE: NHS Scotland buildings identified as "at risk" of structural defects

It follows a report in to Edinburgh school crisis found poor building work was to blame.



"We can exclusively reveal that 51 health buildings across Scotland are structurally "at risk" following the Edinburgh school crisis.

It's feared that the buildings may have similar defects found at 17 Edinburgh primary and secondary schools that were forced to close last year.

Our investigation has discovered Scotland's health boards are now having to carry out repairs in order to make a number of their buildings safe".

Clyde Radio Headline July 2017

Dumfries DG One leisure complex defects 'beggar belief'



A council has said defects found in its flagship leisure centre "beggar belief" and will take about two-and-a-half years in total to fully address.

"It is an absolute disgrace and we feel that we need to investigate the possibility of criminality and how that can be taken forward".

The council also agreed to commission an independent inquiry into the DG One building and its construction so that "all lessons are learned".

Problems have also been found by the Council at Dumfries Ice Bowl and checks are being carried out at the Ryan Centre in Stranraer.

DESIGN AND BUILD PROJECT BY MAJOR UK CONTRACTOR COMPLETED IN 2008

Headline from BBC July 2017

SYSTEMIC QUALITY FAILURES FOUND IN FIRE-STOPPING

- **Major repeated failings were discovered in fire-stopping compromising the fire-safety of occupants and the fabric of all the buildings investigated as part of these Inquiries.**



Roding School London on fire September 2018



INDEPENDENT

[News](#)

[InFact](#)

[Politics](#)

[Voices](#)

[Indy/Life](#)

[Business](#)

[Sport](#)

[Tech](#)

[Culture](#)

[Subscribe](#)



[News](#) › [UK](#) › [Home News](#)

Eight PFI schools built by one of UK's biggest private contractors have fire safety issues

Exclusive: The revelation raises disturbing questions about the safety of public facilities built by the private sector

'Independent' Headline from June 2015

“REPORT INTO KILDARE HOUSING ESTATE BLAZE FINDS INADEQUATE FIRE-STOPPING MEASURES”



*“A report into a fire in a Kildare housing estate in which six homes were burnt to the ground in less than an hour, has highlighted widespread fire safety concerns. The report found there were **numerous deficiencies in the walls that separated the houses including inadequate fire-stopping**”.*

Headline ‘Irish Independent’ 2015

CARLISLE HOSPITAL PFI FACES £14,000,000 FIRE SAFETY REFIT

“The Cumberland Infirmary in Carlisle, Britain’s first NHS hospital financed and built by private capital is a “major” fire safety risk, fire fighters have said.”

Headline Major Daily Newspaper October 2015

A DISASTER WAITING TO HAPPEN

“Urgent safety works have begun at a £380 million PFI hospital in Coventry after inspectors found it was built without fire protection”.

Headline Major Daily Newspaper July 2016

THREE PFI HOSPITALS ROYAL DERBY, WALSALL MANOR IN THE WEST MIDLANDS, AND KING’S MILL IN MANSFIELD, NOTTS HAVING EMERGENCY FIRE-PROOFING.

“There are fears over safety standards at all PFI hospitals after fire officials found others in Hereford and Peterborough were built without fire-proofing”.

Headline Major Daily Newspaper August 2016



14th June 2017



A complex chain of contractors and sub-contractors continues to raise the question of who took responsibility for fire safety during the refurbishment, which was completed only last year.

Headline 'The Guardian' June 2017

**SO WHO IS LOOKING AFTER
THE QUALITY???**

Defective construction of masonry walls

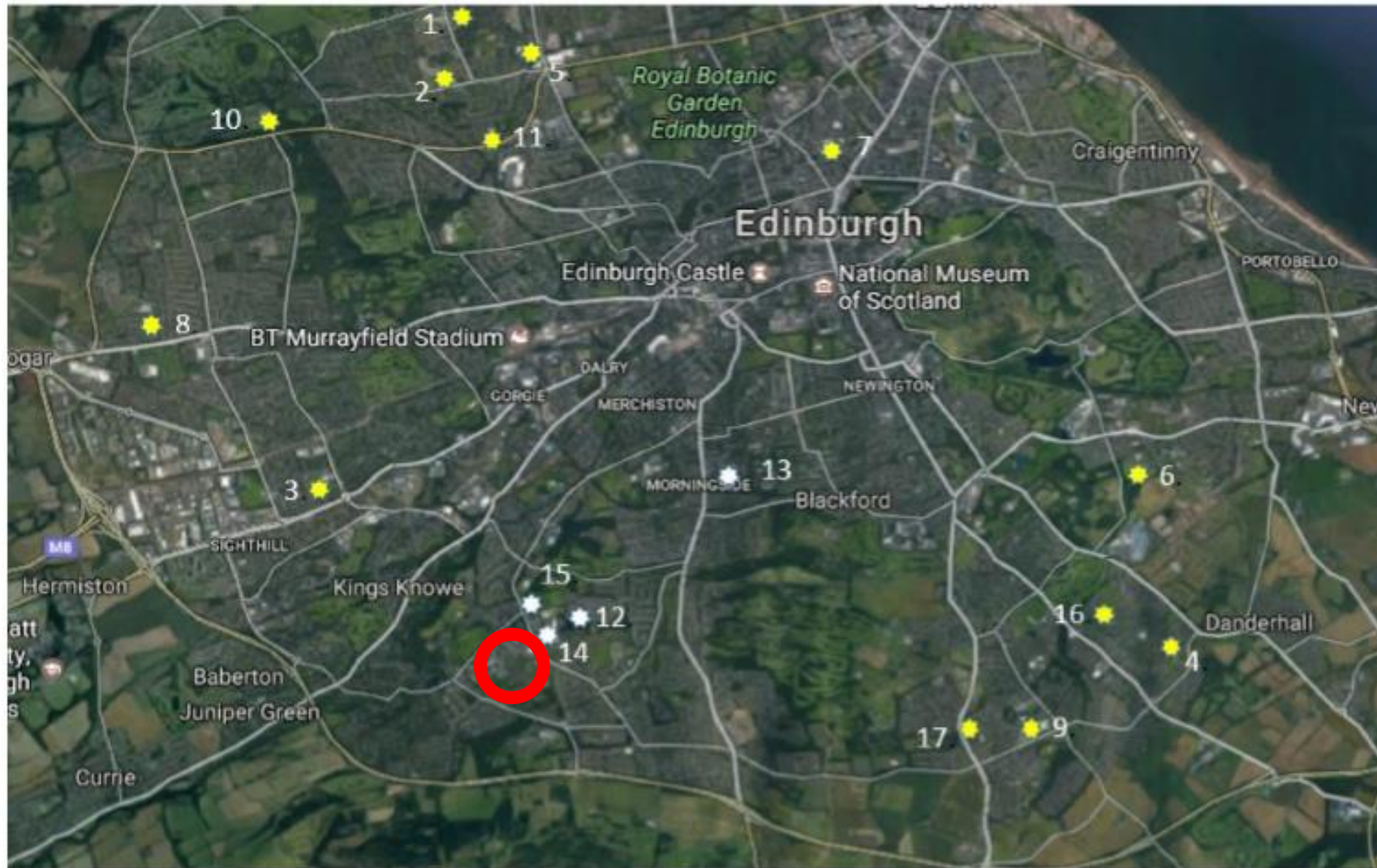


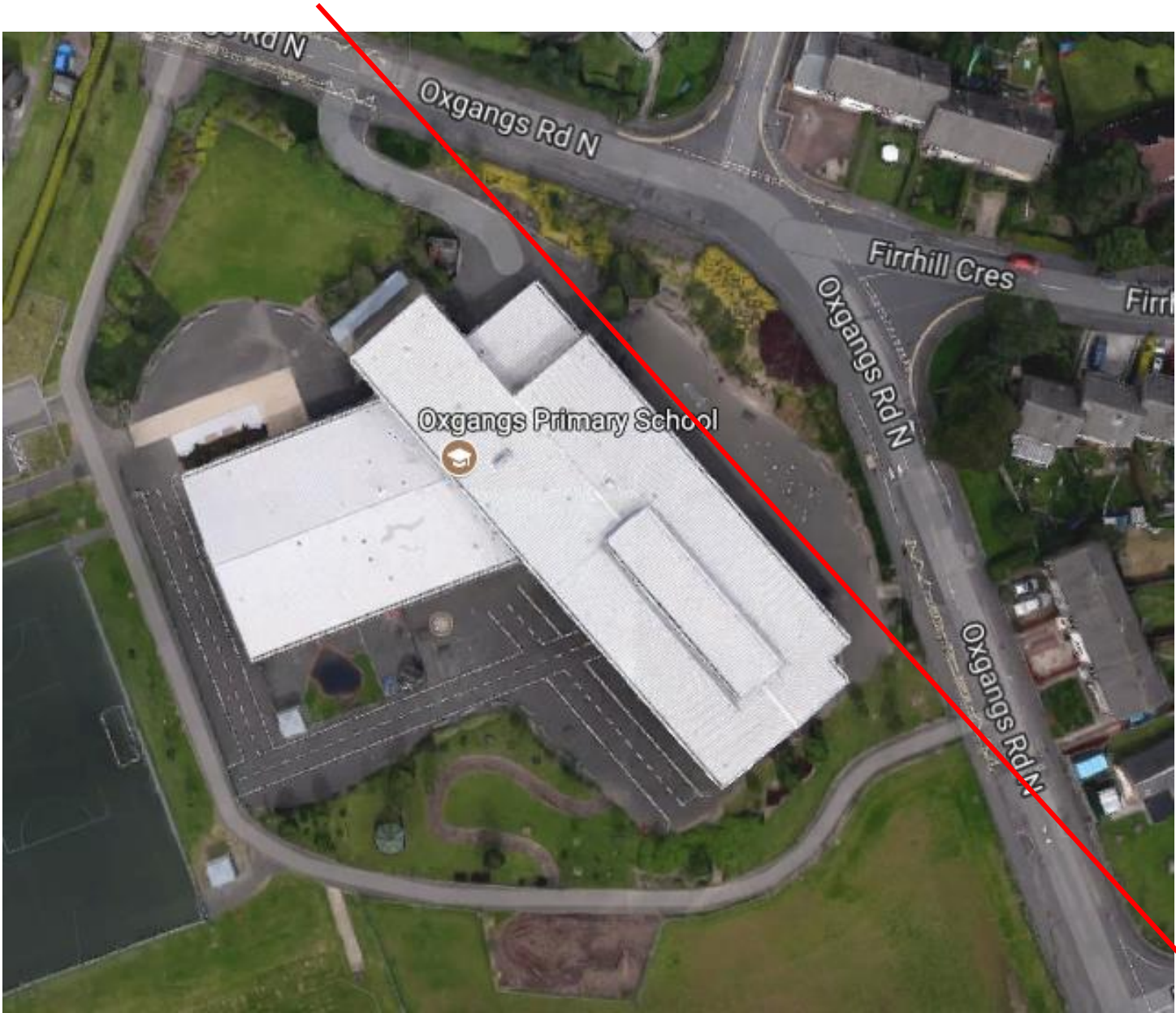


Report of the Independent Inquiry into the Construction of Edinburgh Schools

February 2017

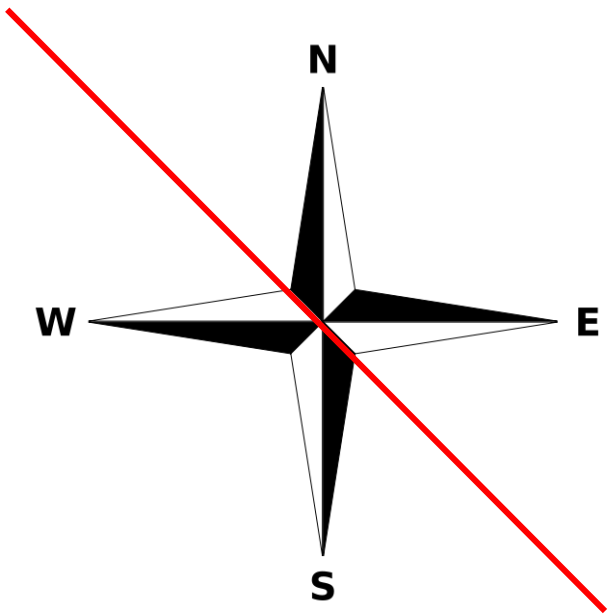
Image 1: Map showing location of the PPP1 schools across Edinburgh.



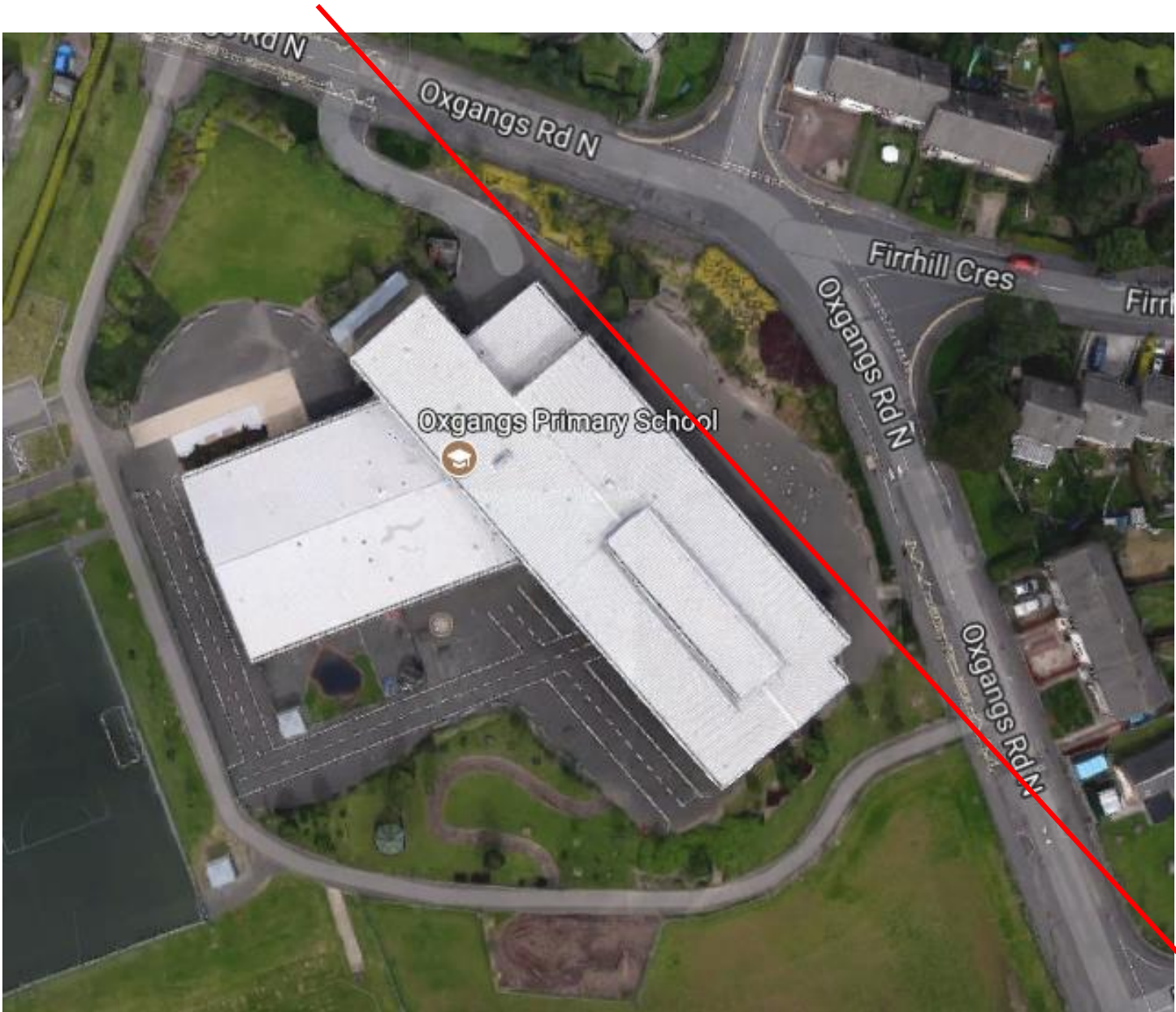


OXGANGS PRIMARY SCHOOL EDINBURGH

Completed 2005 under a Design and Build Contract as part of a large PFI for 17 schools in Edinburgh

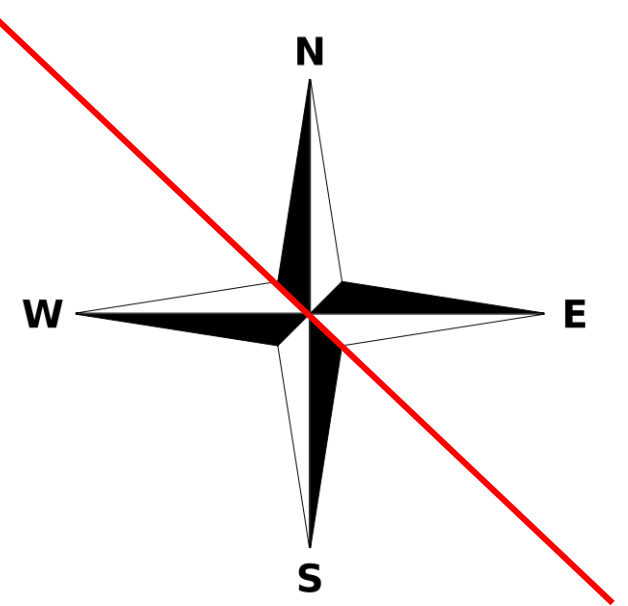


Orientation of main plan NW-SE

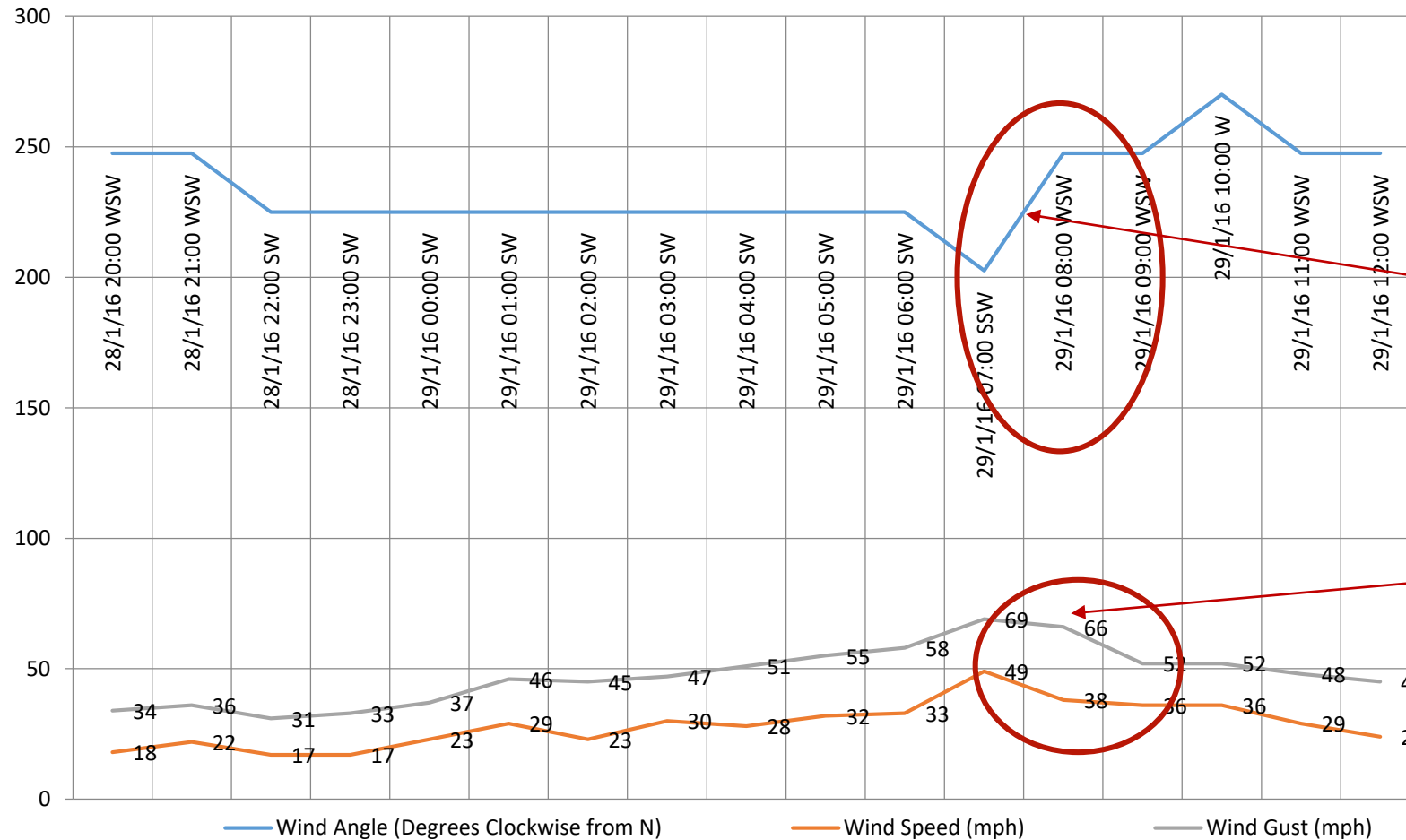


OXGANGS PRIMARY SCHOOL EDINBURGH

On 29th January 2016 9 tonnes of masonry fell from a gable wall on to a pathway below



ANALYSIS OF WIND DIRECTION, WIND SPEED AND WIND GUST SPEED LEADING UP TO THE COLLAPSE OF WALL AT OXGANGS PRIMARY SCHOOL

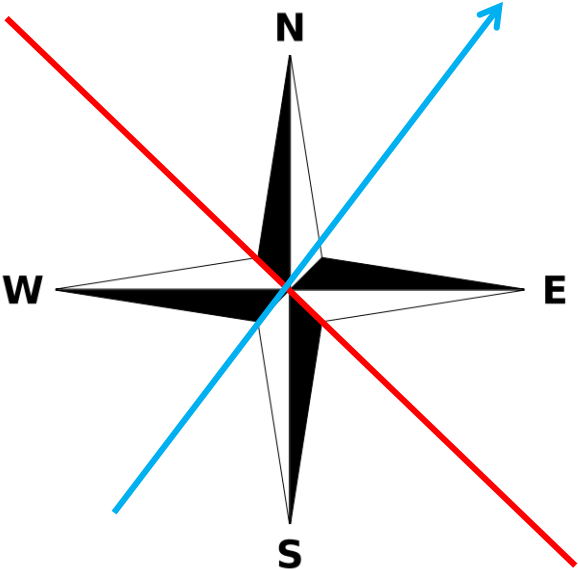


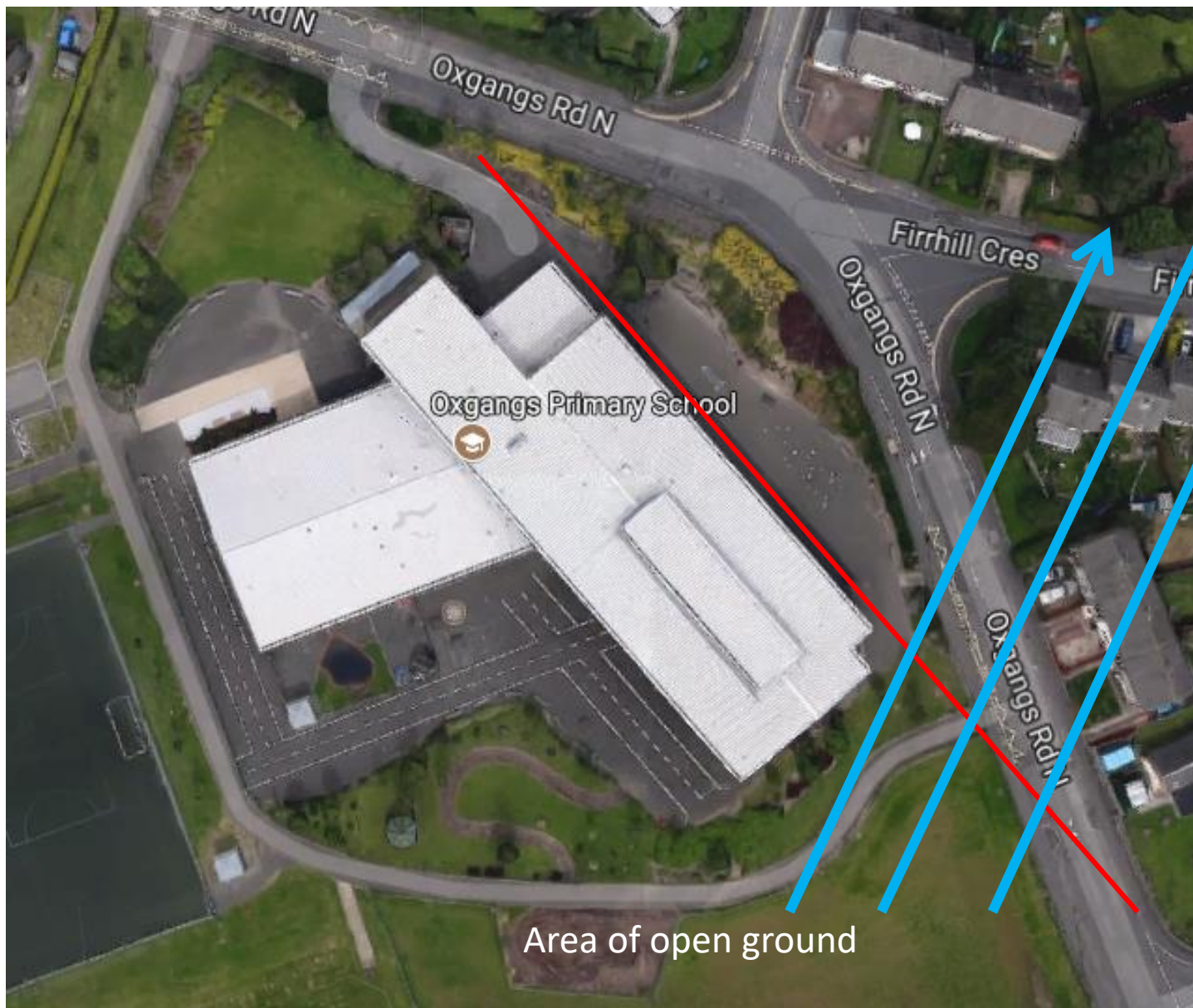
Between 7.00 am and 8.00am the estimated time of the collapse the wind veered from South-West briefly to South-South-West and then to West-South-West

Gust at 69 mph were less than the 99 mph which the design of the walls were required to resist using structural codes



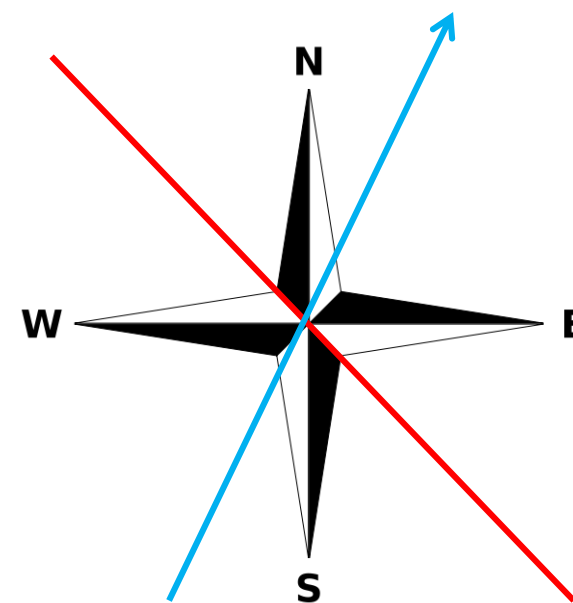
06.00 am:
Wind direction Southwest





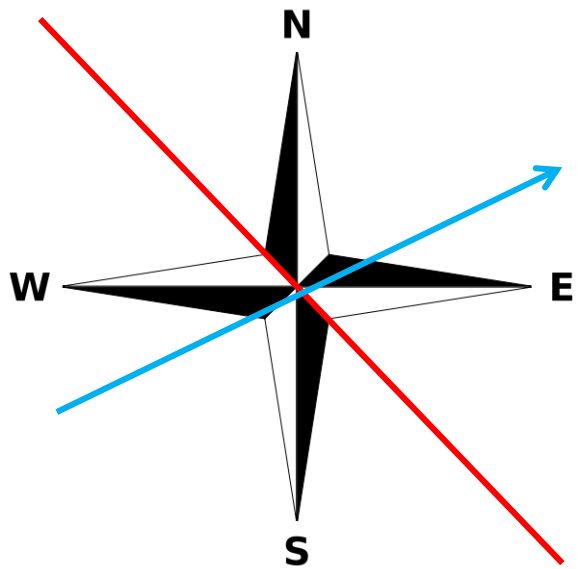
07.00 am:

Wind changes direction briefly to South-Southwest





08.00 am:
Wind veers direction to West-Southwest and gusts up to 69 mph

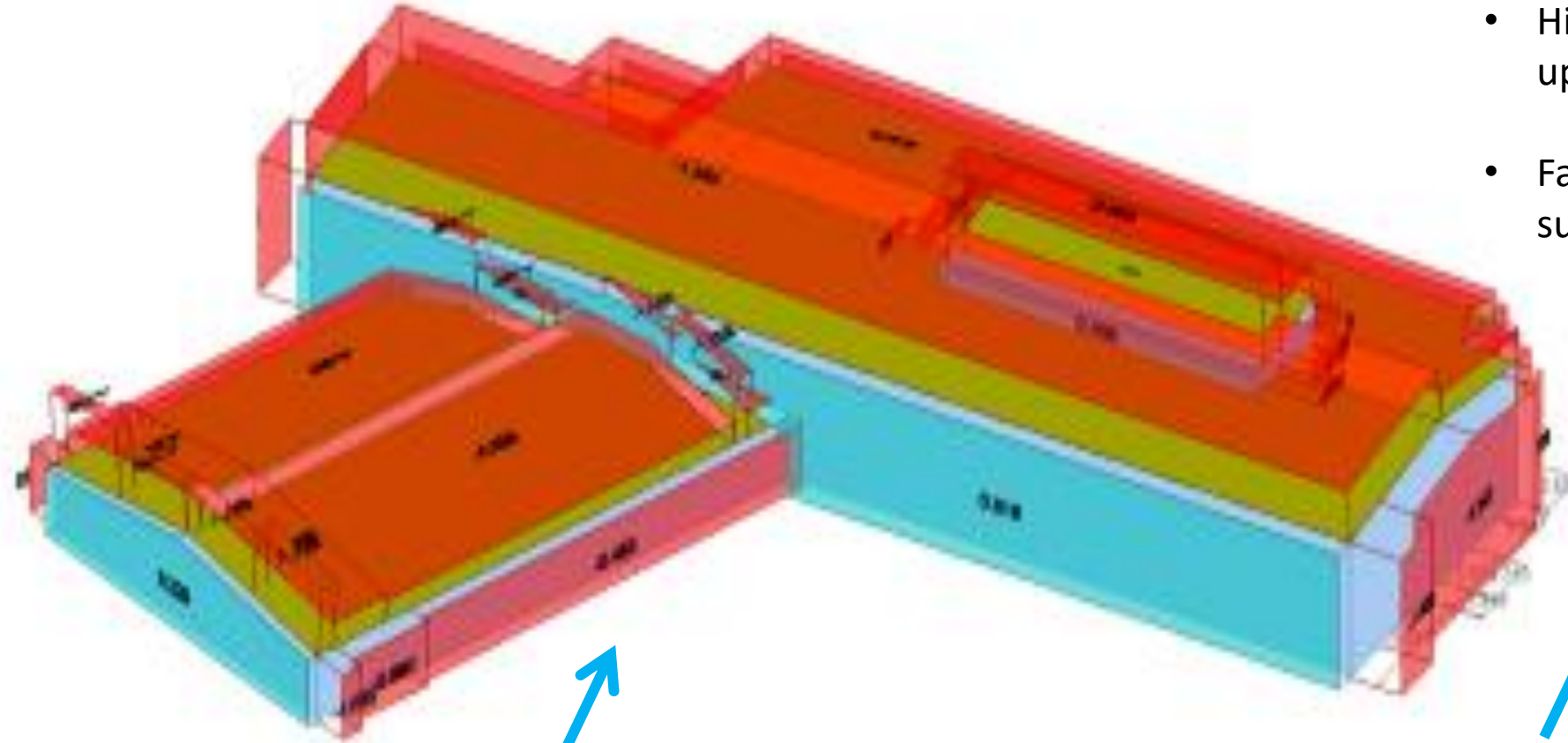


The gable wall collapses

WIND MODEL OF OXGANGS SCHOOL

Blue positive pressure

Pink negative pressure.



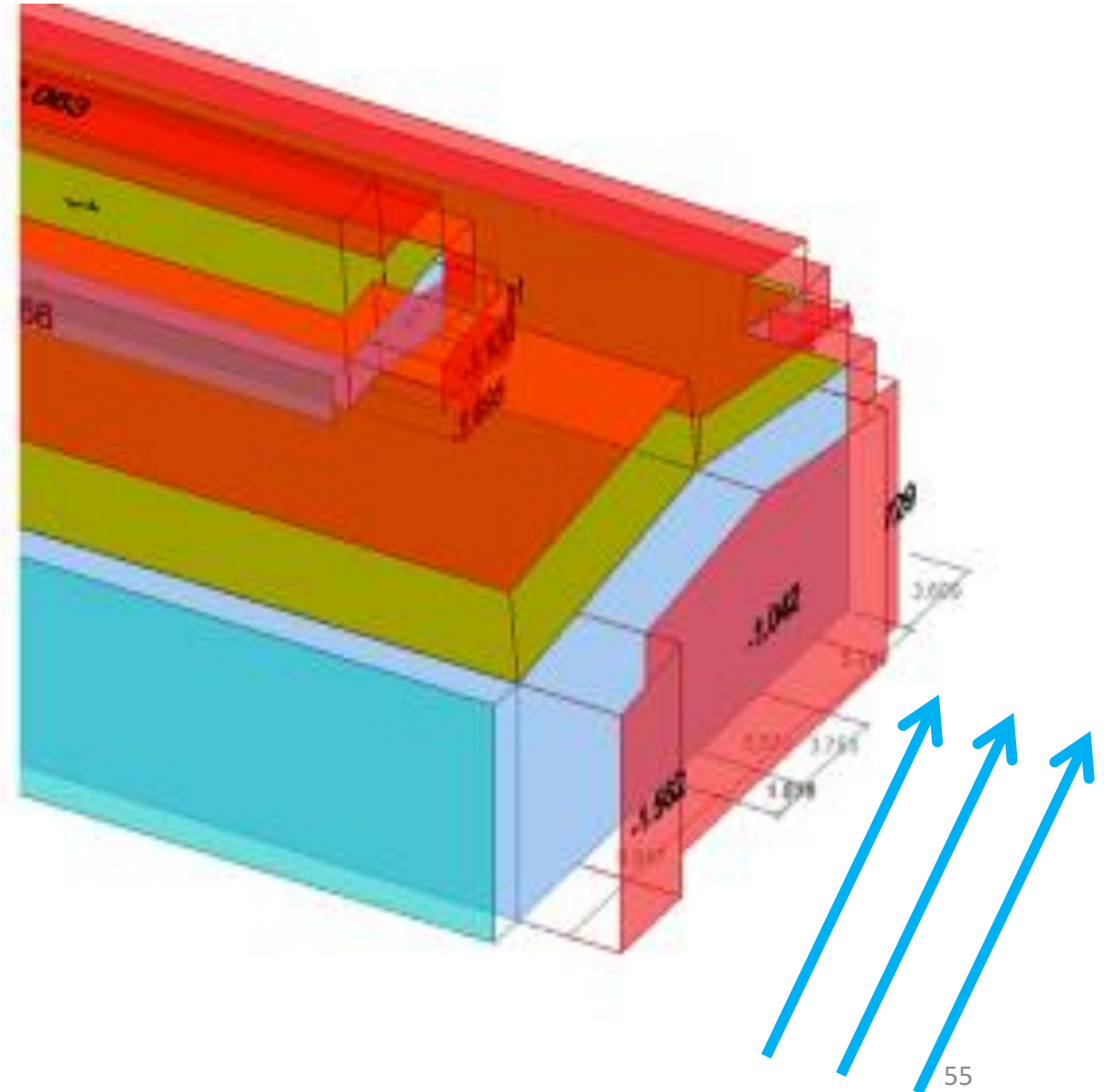
- Highest negative pressures on upper LHS of the gable that fell.
- Failed panels subjected to suction force of up to 1 tonne

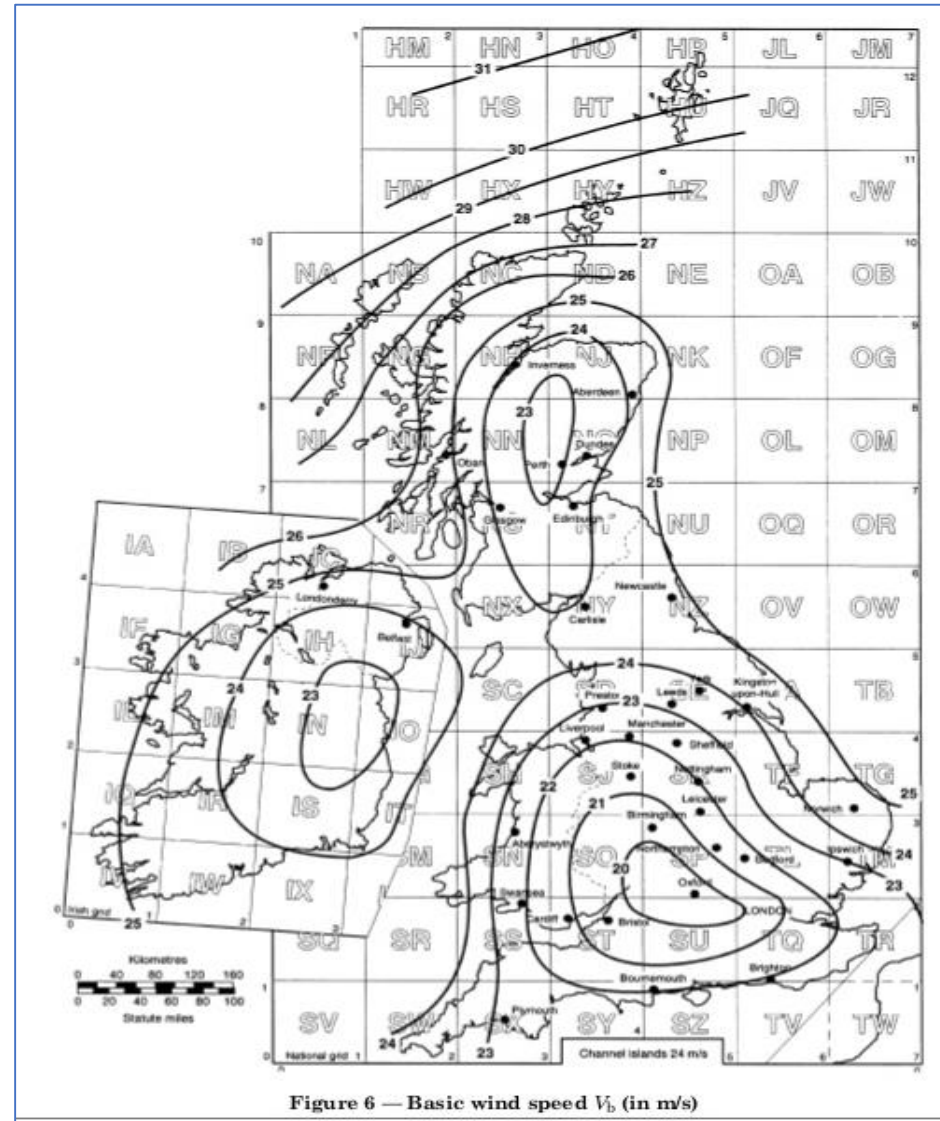
South-West Wind
Design speed 90mph
Actual speed 69mph

- Outer leaf and inner leaf designed to act as one through properly spaced and embedded wall ties
- Each masonry panel to be tied back to the structural frame

FACTORS OF SAFETY IN DESIGN OF MASONRY PANELS

- With some ties having little embedment, others **have to transfer higher loads than intended and increase risk of failure**
- The Factors of Safety used in designing panels take account of quality of materials and construction to be delivered.
- The standard safety factor used is 3
- Lower factor of safety of 2.5 allowed if high levels of supervision on-site and material testing specified





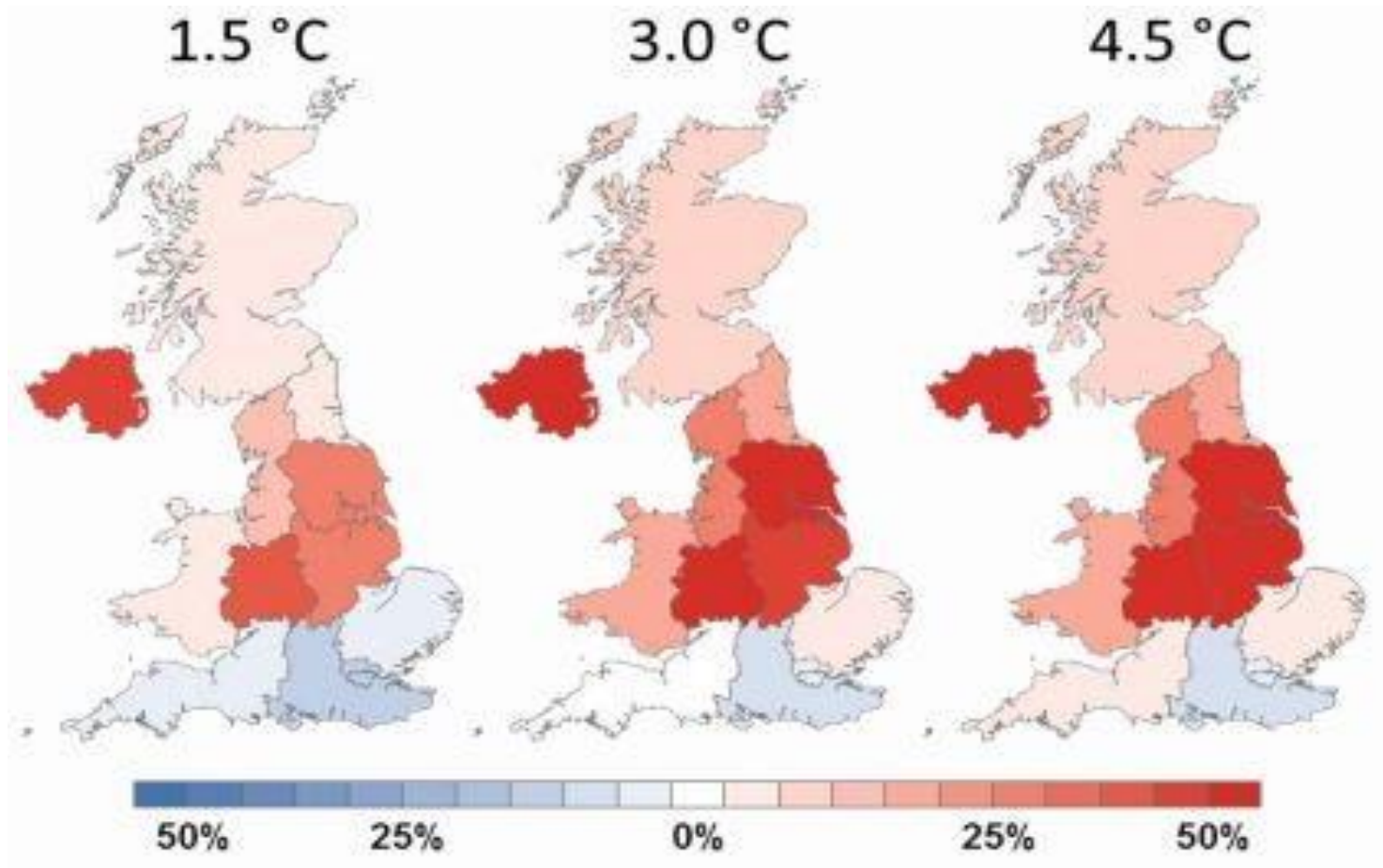
BRITISH STANDARD BS 6399-2:
1997
Loading for buildings — Part 2:
Code of Practice for Wind Loads

Note: 24 m/s = approx. 54 mph

Climate change likely to increase risk of costly storms

16/05/2017

New analysis shows impact of temperature rises on insurance claims for wind storms



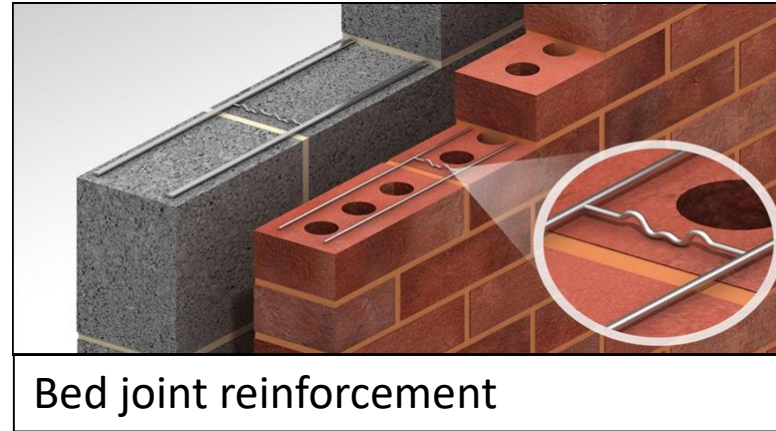
The impact of climate change on the UK is likely to mean a higher number of more expensive wind storms, the insurance industry warns today.

Predicted change in regional average annual losses from wind storms

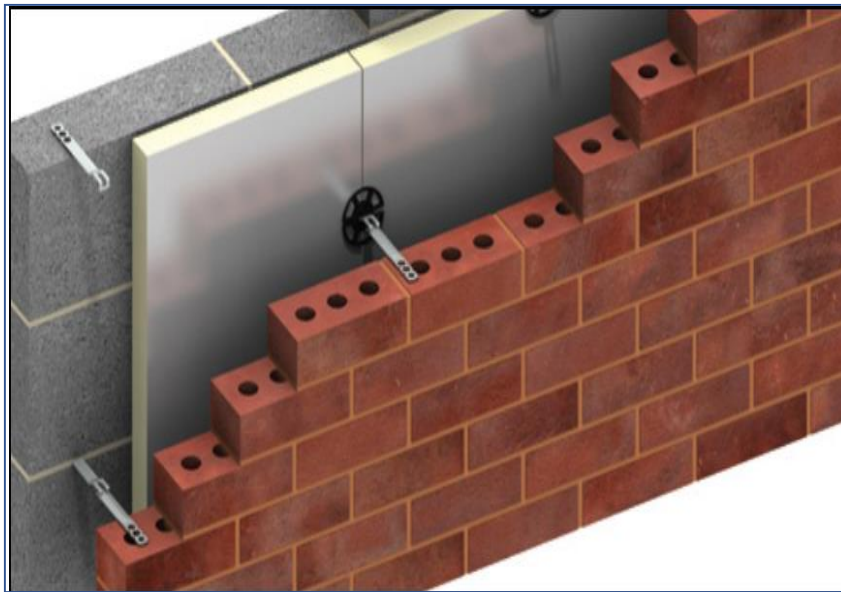
GENERAL EXTERNAL WALL CONSTRUCTION SPECIFIED



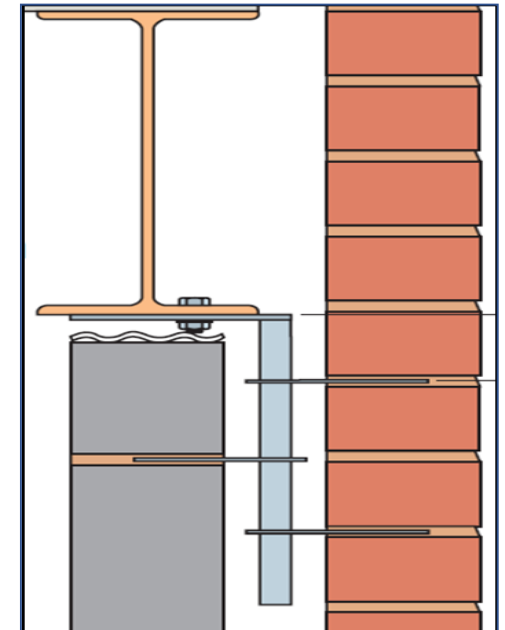
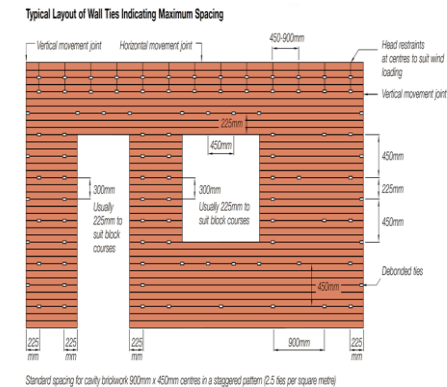
Wall ties specified were **250mm** heavy duty strip ties such as Vista VT1 with minimum embedment in each leaf of not less than **50 mm**



Bed joint reinforcement



General specification of cavity walls throughout schools was 140 mm inner blockwork, 120 cavity containing 70 mm insulation clipped to inner face and outer leaf of 102.5 mm facing brickwork or 100 mm rendered blockwork



The head restraints specified fix both blockwork Inner leaf and brick outer leaf to steel eaves beams

AN INCREASINGLY COMMON PRACTICE OF BUILDING THE INNER LEAVE FIRST

- The evidence indicates that the inner blockwork leaf was built first to achieve an earlier dry enclosure despite the specification.
- Evidence suggests that this had been pointed out to the Contractor as a breach of the specified requirements by at least one of the three firms of architects appointed by the contractor
- ***535 - Height of Lifts***

Raise no portion of the work more than 1.2 m above another at any time

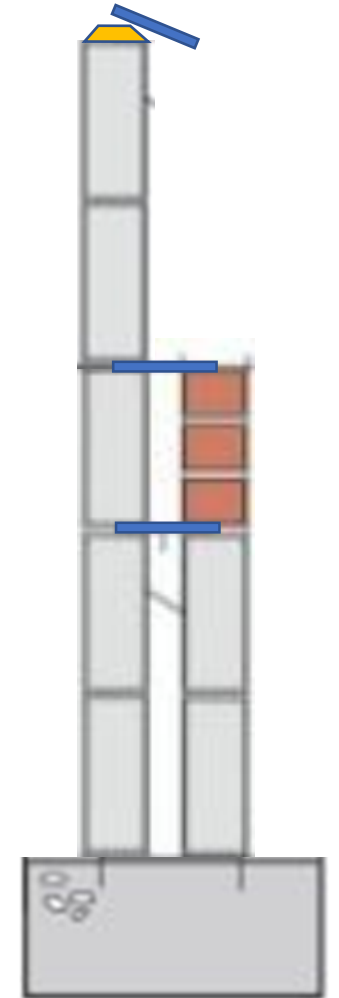
Do not carry up one leaf more than 1.5 m in any one day unless permitted by the CA

- ***- Levelling of Courses***

Bring both leaves of cavity walls to the same level at every course containing vertical twist type ties or other rigid ties

PROBLEMS ASSOCIATED WITH BUILDING INNER LEAF FIRST

- Centre of gravity of wall ties lies outside the inner block leaf : reliance on mortar suction to hold tie in place
- Risk of overbalancing; wall ties falling out before mortar cures
- To avoid this tendency to position ties further into inner leaf than necessary not leaving enough for embedment in outer leaf
- Or pushing ties into still wet joints after building the brickwork causing voids
- Also bricklayers following the flange line of steelwork stanchions in the inner leaf that can be erected slightly off-plumb
- Then if the outer leaf is built plumb this can lead to a widening cavity as the wall rises
- Also risk of misalignment in the coursing between leaves exacerbated by inflexibility of heavier type wall-ties used
- Different squads used for blockwork than brickwork; frequently less skilled





Oxgangs P.S. Edinburgh – one of seventeen schools built by 6 different contractors using D & B contracts as part of a single overarching PFI contract



8.00 am on morning of collapse



Example of 9.00 am on a normal morning

**‘SIMPLY A MATTER OF LUCK AND
TIMING’**

INITIAL REPORT ON THE GABLE PANEL THAT FELL AT OXGANGS

"A combination of excessive cavity width, related non-verticality, incorrectly constructed wall ties, has resulted in a cavity wall construction which had insufficient embedment in many of the wall ties in the outer leaf. This in our view was the primary contributory factor." WRD Report

- Width of cavity to the collapsed wall assessed to range between 15mm to 40mm wider than specified 120mm;
- Measurements of wall ties left in the inner leaf after collapse showed over 50% of these insufficiently long to provide minimum embedment of 50mm in outer leaf
- In bay containing diagonal steel bracing, blockwork to inner leaf was reduced from 140mm to 100mm locally around the bracing increasing cavity width to 160mm and making 50 mm embedment either side impossible with 250 mm tie
- Report recommended precautionary investigations of the remaining walls in the school



Bay with diagonal steel bracing showing part of blockwork reduced from 140 mm to 100 mm increasing width of cavity to 160 mm although the same 250 mm long wall ties were used



Areas of wall-tie spacing not as it should be with ties pulled out or not there in first place



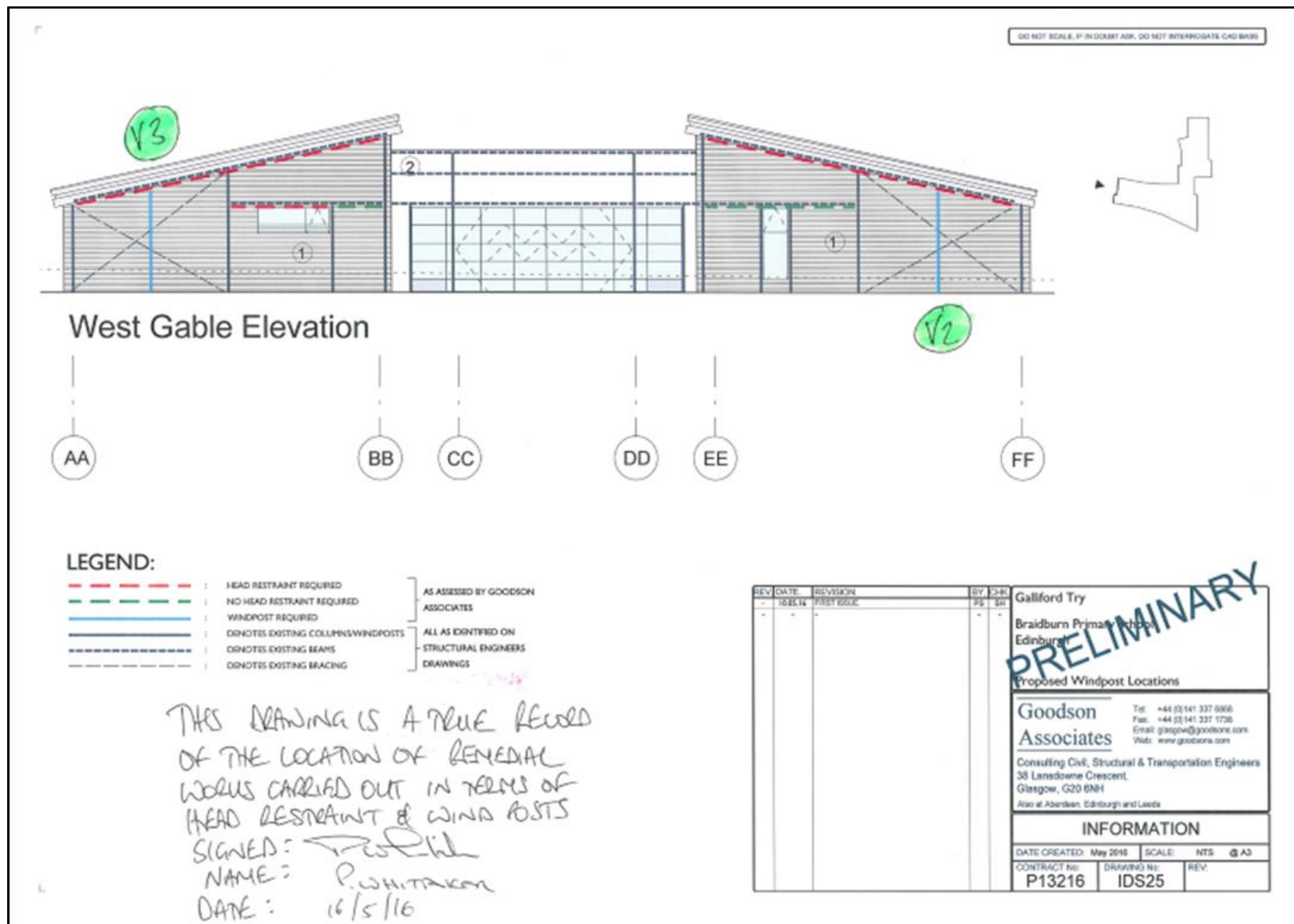
EXAMPLES OF NIL OR LITTLE
EMBEDMENT AS RECORDED BY
THE REMEDIATION CONTRACTOR
FOR EDINBURGH SCHOOLS



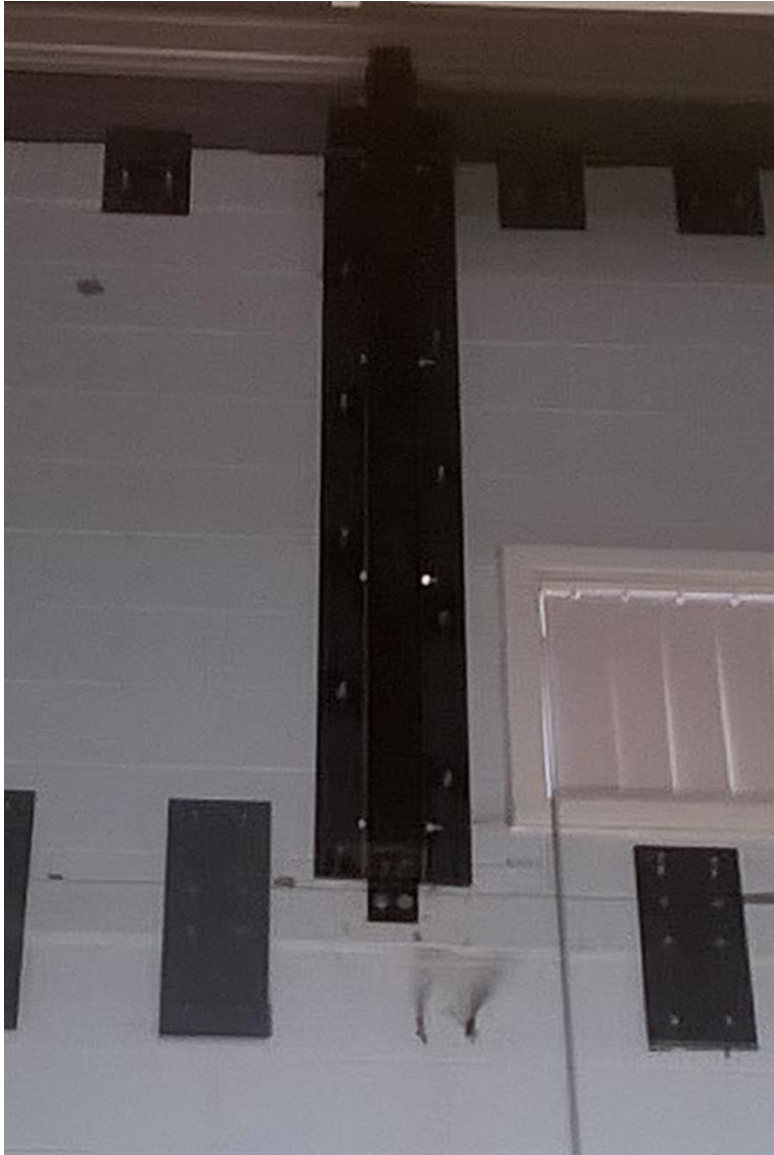
EXAMPLES OF NIL OR
LITTLE EMBEDMENT AS
RECORDED BY THE
REMEDIATION
CONTRACTOR FOR
EDINBURGH SCHOOLS



EXAMPLES OF NIL OR LITTLE EMBEDMENT RECORDED BY THE REMEDIATION CONTRACTOR FOR EDINBURGH SCHOOLS



REMEDATION CONTRACT
DRAWING FOR BRAIDBURN
SCHOOL EDINBURGH
SHOWING REQUIREMENT FOR
INSTALLATION OF MISSING
HEAD RESTRAINTS AND
ADDITIONAL WIND-POSTS



Above: Remedial horizontal and vertical windposts. boxed in at Drummond School.

On left: Typical retrofitted vertical windpost spanning from intermediate horizontal beam to roof beam and wall head restraints fitted to both intermediate and roof beams.

EXTRACT FROM SURVEY OF DEFECTS AND OMISSIONS IN SCHOOL WALLS

Name of School and Contractor	Number of Masonry Panels tested	Percentage of Cavities checked that were <u>outside</u> Permitted Tolerances	Percentage of Ties exposed that had Inadequate Embedment	Percentage of Wall Panels that had Remedial Wall Ties installed	Percentage of Panels investigated for Head Restraints which had no HR's Found	Percentage of Wall Panels that had Remedial Wall Head Restraints installed	Percentage of Panels investigated that had missing Bed Joint Reinforcement
Howdenhall Centre	22%	5%	40%	78%	59% Plans for main building show 100% missing at attic level. In gym hall.	34% ⁵	Information not available
Rowanfield SS	42%	25%	67%	42% ⁶	50%	74%	50%
Craigmount HS	40%	14%	60%	45% ⁷	16%	8% ⁸	100%
Drummond HS	32%	11%	63%	86%	100%	63% ⁹	57%
Gracemount High School	34%	40%	75%	68%	Information not available	19%	100%
The Royal HS	22%	14%	33%	40%	67%	59% ¹⁰	Information not available



EXAMPLES OF MORE THAN 300 BREACHES OF FIRE COMPARTMENTATION IN 17 EDINBURGH SCHOOLS

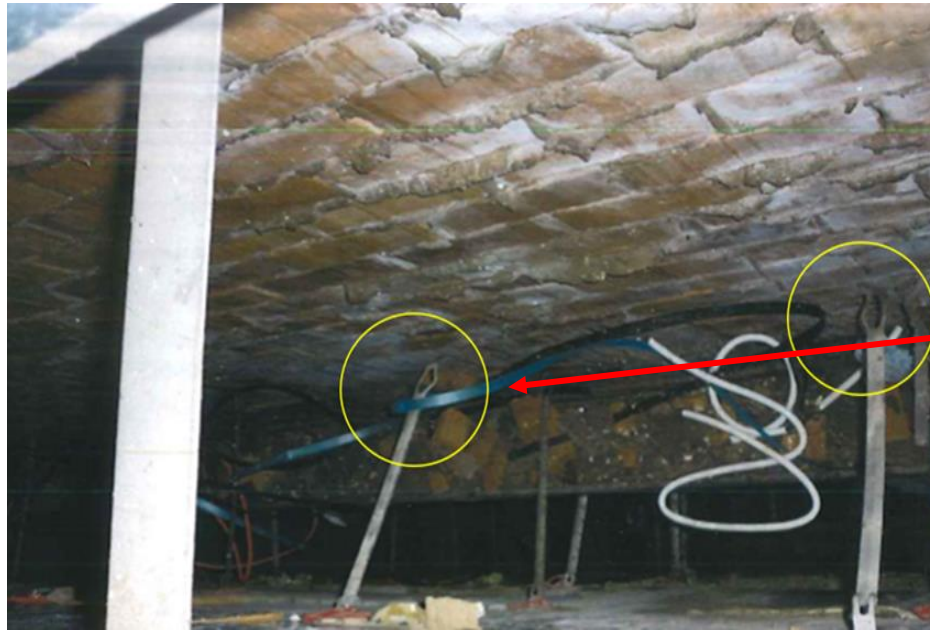
CONCERNS OF SYSTEM FAILURE IN THE INDUSTRY ARISING FROM THE INQUIRY

- Six different main contractors built the 17 Edinburgh schools each with their own approved QA systems
- Different brick-laying sub-contractors used, each sub-contractor with their own approved QA system
- 3 firms of architects and one firm of structural engineers each with their own approved QA system
- Two national firms acted as Independent Testers each with their own approved QA system
- Building Control inspections carried out
- Despite these QA systems the following five fundamental defects occurred at a consistently high level :
 - Varying cavity widths significantly beyond acceptable tolerances
 - Lack of embedment of wall-ties or missing wall-ties;
 - Omissions of specified head restraints and in places lateral restraints;
 - Omissions of specified bed joint reinforcement
 - Defective and missing fire-stopping throughout the 17 schools

So who was looking after the quality???

NOT AN EDINBURGH PROBLEM OR A SCHOOLS PROBLEM IT IS AN INDUSTRY PROBLEM

- The Inquiry sought information from all Scottish Local Authorities and found that the same fundamental defects were present in many schools from across all parts of Scotland
- In the previous 4 years 2012 -2016 AT LEAST 5 COLLAPSES OF EXTERNAL BRICK PANELS IN RECENTLY BUILT SCOTTISH SCHOOLS; the causes in all cases virtually identical to the incident in Edinburgh.
- No effective coordinated overview to link these as an Industry-wide problem that needed addressed
- **In February 2017 the Inquiry concluded on the basis of the evidence presented that similar defects were likely to be widespread throughout the Industry and recommended proactive risk-assessed investigations should be undertaken by public and private bodies across Scotland**
- **The Inquiry found that clients should not rely solely on the quality assurance processes of the Industry and should provide for their own independent expert scrutiny**



Photographs from 4 different recently built schools from outside Edinburgh showing examples of:

- no embedment of wall ties;
- deformation of wall-ties due to misalignment of coursing;
- a total absence of wall ties



Trinity High School South Lanarkshire completed in 2009 as part of a PFI contract. It has the same pattern of collapse as at Oxfangs P.S. and also occurred in a period of high wind



Trinity High School Lanarkshire D&B under PFI
built 2009



Oxgangs Primary School Edinburgh D&B under PFI
built 2005

Report of the Independent Inquiry
into the Construction of the
DG One Complex in Dumfries



APRIL 2018

Dumfries DG One leisure complex defects 'beggar belief'

🕒 25 February 2015 | South Scotland

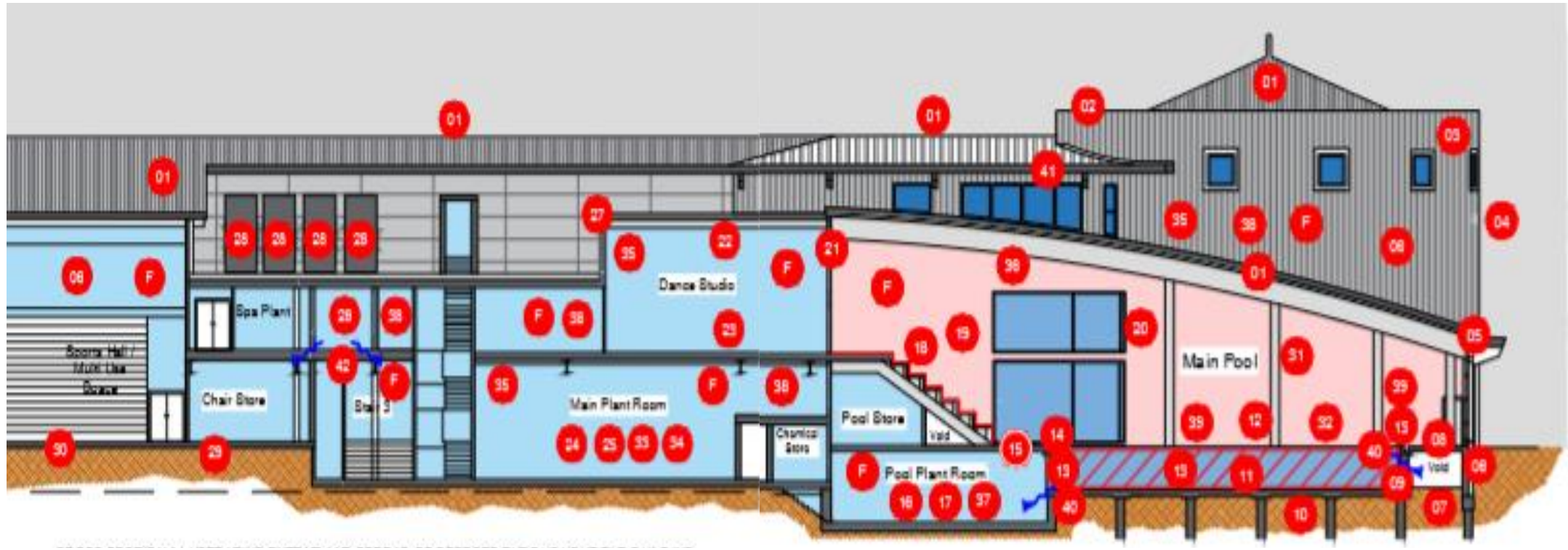
[f](#) [🐦](#) [💬](#) [✉](#) [Share](#)



DESIGN AND BUILD PROJECT BY MAJOR UK CONTRACTOR COMPLETED IN 2008

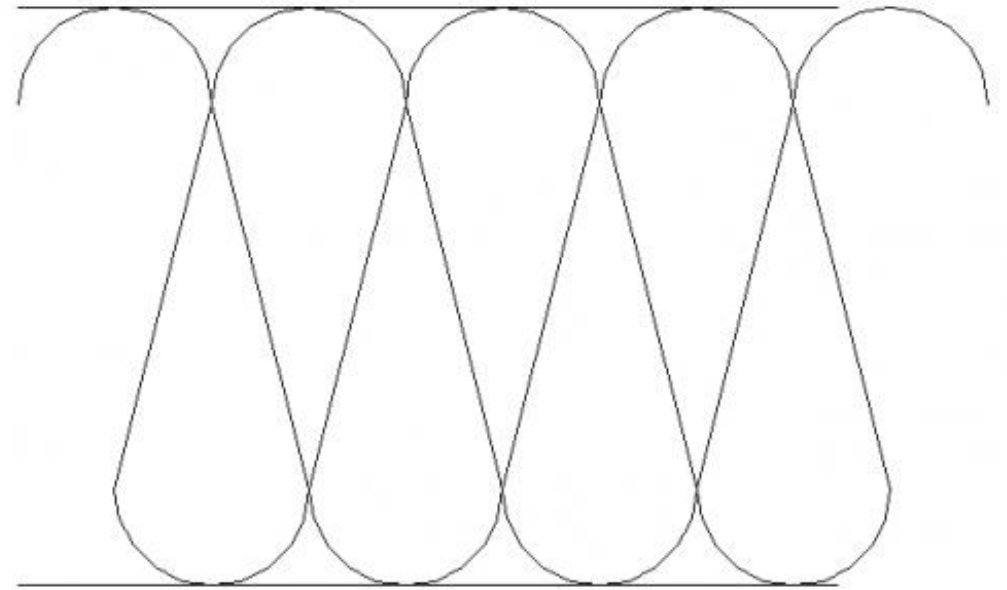
Independent Inquiry reported in April 2018

A council has said defects found in its flagship leisure centre "beggar belief" and will take about two-and-a-half years in total to fully address.



SECTION SHOWING RANGE OF LATENT DEFECTS DISCOVERED IN DUMFRIES LEISURE CENTRE

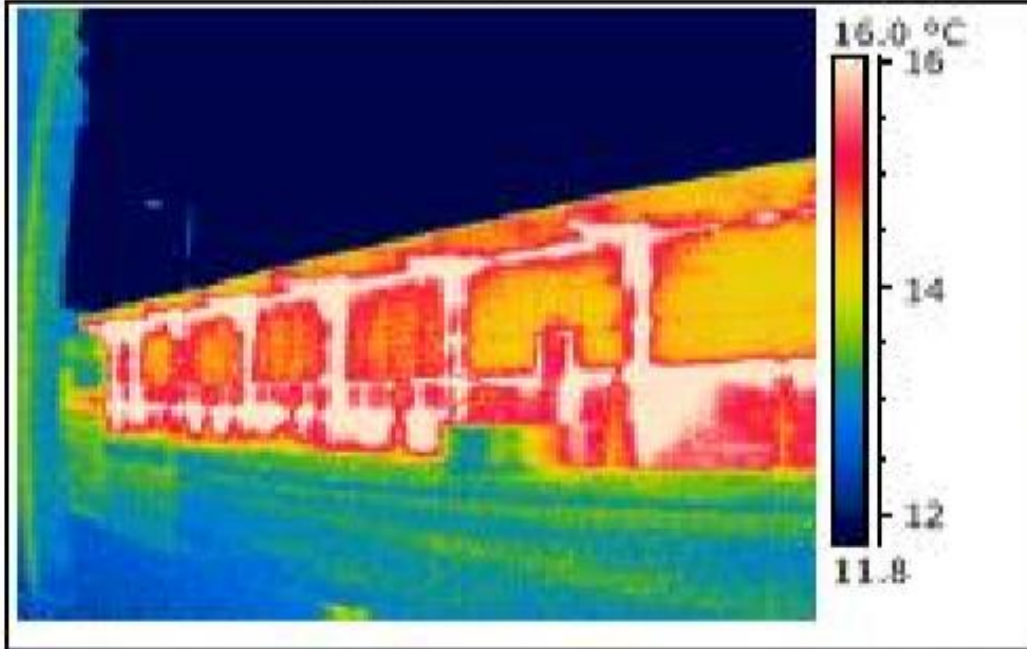
DEFECTIVE INSTALLATION OF INSULATION



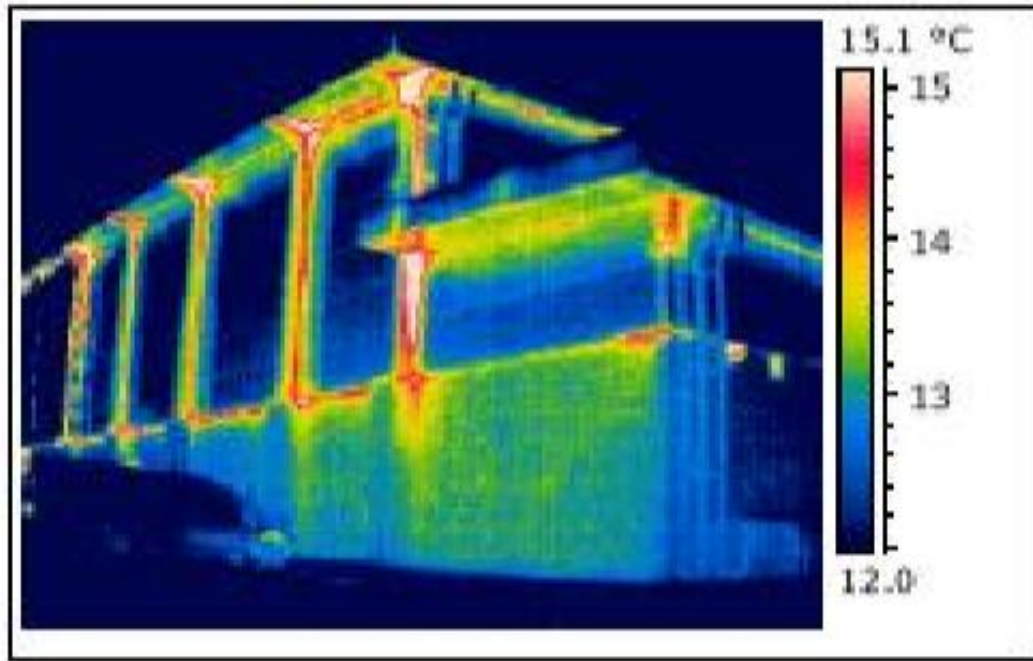


Street elevation of DG One building showing efflorescence due to constantly saturated wall

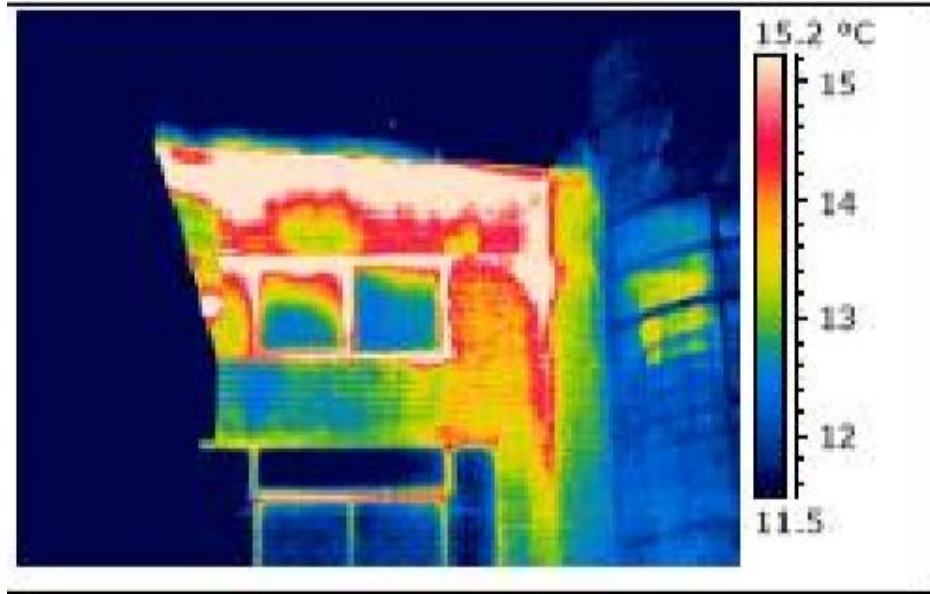
Date & Time:



The east façade to the pool hall exhibits significant heat losses across the base walling and around junctions between wall heads and soffits indicating missing and poor installation of insulation panels



West façade showing excess heat loss through column cladding locations and at roof junctions evidencing poor detailing, cold bridging and missing insulation



North end showing excess heat loss to wall head area and inadequate wall head/roof junctions seals , seals around windows and insulation behind timber cladding



Test smoke rapidly escaping through eaves junction demonstrating lack of air-tightness



Test smoke pouring into dance studio from Wet area of building



Isolated pieces of insulation below floor level but none above and through corner where cold bridge occurs at steel column



External wall Insulation missing



Large gap between roof and wall insulation



Continuous gap of insulation at eaves

Type of Construction of External Envelope	U-Value Specified in Sport Scotland Guidance to be complied with under the Employer's Requirements	As-constructed	Short-fall
Brick / block inner leaf cavity wall construction	0.2 W/m ² K	1.88 W/m ² K	1.68 W/m ² K
Kingspan panel / block inner leaf	0.2 W/m ² K	1.94 W/m ² K	1.74 W/m ² K
Pool floor	0.166 W/m ² K	0.4 W/m ² K	0.234 W/m ² K

DEFECTIVE INSTALLATION OF FIRE-STOPPING





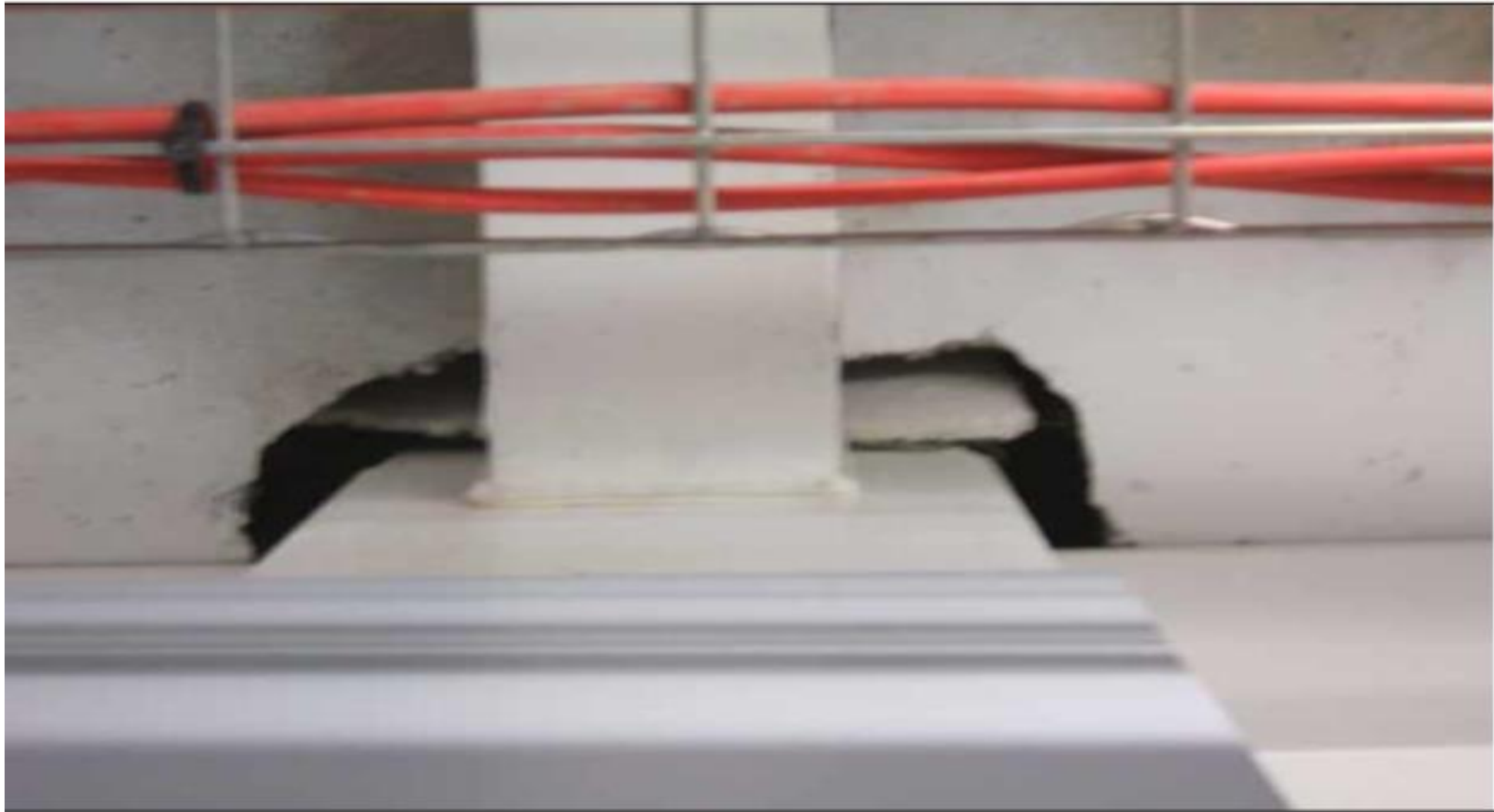
Unsealed hole as services pass through 1-hour fire resisting wall



Two examples of the many major omissions of essential fire-stopping, one in an escape corridor and second in the floor slab of a first-floor plant room



Void to lift shaft and floor below not fire or smoke sealed



Voids around columns and beam junctions to escape corridor without fire and smoke seals



Void above beam in wall to escape route without fire or smoke seals



Ducts passing through plant room walls without fire or smoke seals



Major gaps in firestopping



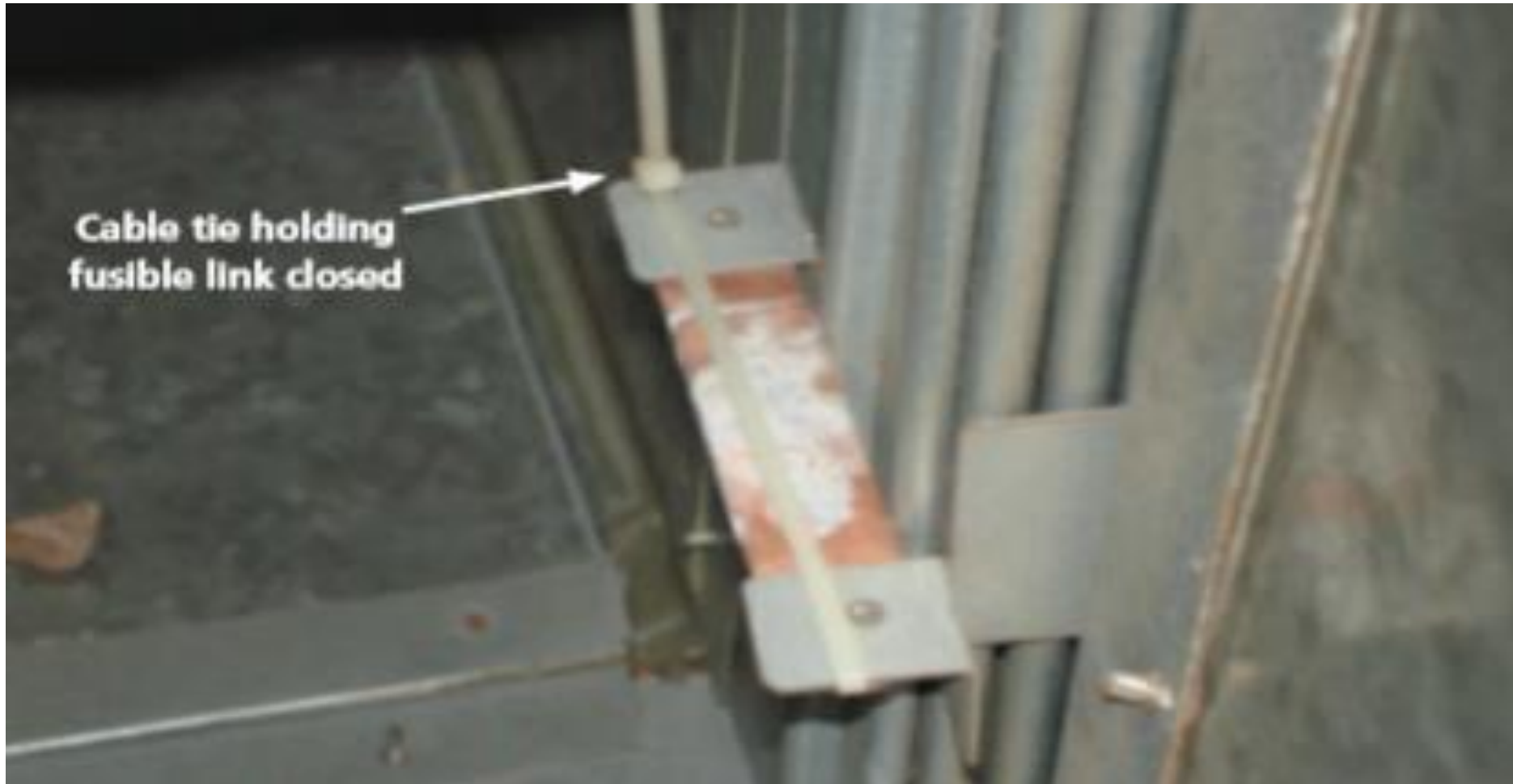
Major gaps in firestopping



Major gaps in firestopping



Major gaps in firestopping



Cable tie used in transit found still in position after several years preventing fire-damper from operating

Corrosion of structural
elements and fittings
throughout building





Examples of corrosion to steel fittings throughout the wet area found to be 304 grade steel as opposed to specified grade 316



Corrosion of metal fittings throughout building



Impact of leaks from first floor area and corrosion to structural steelwork immediately below



Domestic funnel wired in place by the contractor as catch vessel for major leak in ceiling void above changing area. Wire corroded and timber untreated



A corroded steel beam (*and its reflection in a mirror*) in the screed below an opened section of tiling.



Corrosion of steel reinforcement and staining of surrounding concrete in pool walls. Above is an example of a corroded bar removed from the pool tank wall showing depleted section as a result of corrosion



Examples of damage to pipe insulation and to galvanised fittings in plant room



Severe corrosion evident to electrical and mechanical services from leaking pool chemicals and condensation



Polythene sheeting protecting electrical switchgear from overhead water leakage caught in carefully positioned bucket



Corroded base of steel column in main plantroom



Saturated damp and efflorescence in void under pool area



External and internal faces of saturated cavity wall



Steel columns indicated with red arrows are rusted and corroded



Corroded underfloor sections of steel columns

Defective drainage
throughout





Discharge from dance studio roof directly onto pvc membrane and ponding due to ineffective drainage



Examples of inadequately joined, supported and sealed drainage in the building voids under DG One



An example of the condition of underfloor drainage found

Defective
construction of
masonry walls





BEFORE



AFTER



Nov 2011 photographs – no visible evidence of wall ties



Wall ties not embedded in outer face and insulation missing



No inner leaf blockwork between Kallwall glazing panels and column. External brickwork has no tie back



Scaffold tube remaining from original construction revealed on removal of cladding. Timber and insulation boded around tube



No supports to head of blockwork and inadequate supports for external cladding

Defective Installation of External Finishes





Poorly fitted and sealed flashing



Potentially dangerous delaminating coverings to roof ducts



Examples of widespread corrosion to plant fittings including AHUs on roof



Uneven staining of timber cladding



Impact on appearance of brickwork due to its saturation



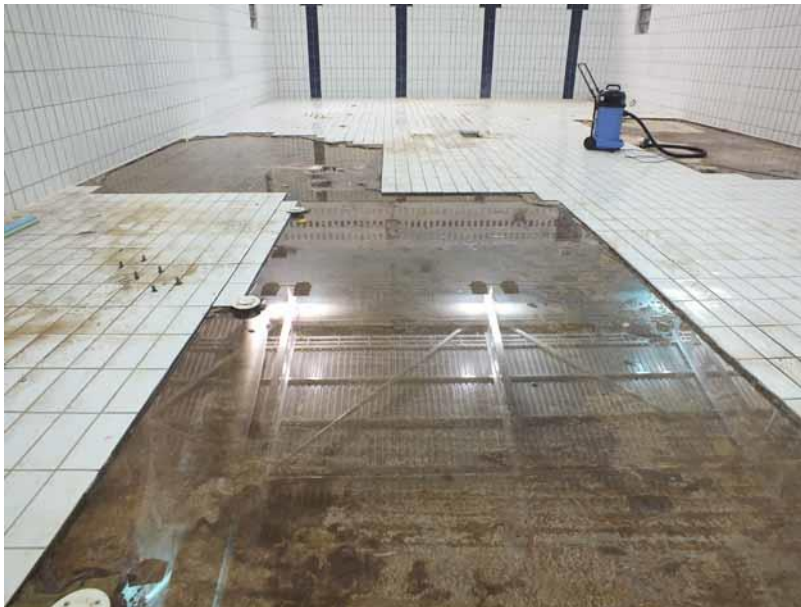
Poor external workmanship and detailing



Defects in tiling











QUALITY ASSURANCE ON DUMFRIES

- Major national contractor
- Voluminous section of contractor's tender submission describing quality assurances processes and certificates
- Director from Main Contractor invited to be member of the Council's Project Board
- Regular inspections of work by members of design team specified in the scope of services set by contractor and collateral warranties provided to Council
- D&B procurement chosen as more likely to achieve tight cost and time objectives
- Council officers' relied on seeking to ensure the legal terms of the D&B contract protected their interest by transferring as much risk as possible to contractor

QUALITY ASSURANCE ON DUMFRIES

- Employer's Agent a civil engineer and unfamiliar with D&B form of contract
- Only part-time Clerk of Works and from a civil engineering rather than building background.
- Client was not advised as to whether specified inspections by design team took place nor provided with any reports of inspections. Contractor took case against designers.
- Site Construction Manager changed 5 times during project
- Evidence of reluctance by client to instruct contractor on quality issues in case this may bring risk back to Council. No effective informed independent scrutiny by client body

BUILDING STANDARDS PROCESSES

- Staged design warrants used to allow early commencement on site however only stage 1 warrant for foundations etc. was approved before construction
- Stage 2 and stage 3 warrants were not approved until month 23, only 2 months before completion of project which finished 7 months late
- Significant changes in submitted design made during construction by sub-contractors without notification or request for amendments to warrant
- Limited number of inspections by building inspectors. Building opened with Temporary Occupancy Certificate which expired after 2 months
- Building Standards acceptance of completion certificate not approved until year later
- Major areas of non-compliance subsequently discovered forcing closure of building

THE TRUE COST OF POOR QUALITY FOR DUMFRIES

	£000s
Original cost of the new DG One facility in 2008 (including construction cost of £12.67 million, fees, site purchase and ancillary costs)	17,341
Additional costs incurred by the Council associated with the closure of DG One and pursuit of the legal claim against Kier	4,220
Current assessment of final reinstatement of DG One	20,963
Total Cost	£42,524
Less amount of settlement received from Kier	(9,500)
Net Cost of DG One to the Council	£33,024

SO WHO WAS LOOKING AFTER THE QUALITY?

COMPROMISES UNDER THE D&B CONTRACTS THAT CONTRIBUTED TO QUALITY FAILURES IN EDINBURGH AND DUMFRIES

- Failure to fully integrate and coordinate the design and detailed specification of works before construction began
- Failure to confirm that design complied with Building Regulations before construction
- Reduced or totally absent independent scrutiny of construction on behalf of the client by original design team members and by properly resourced clerks of works or resident architects/engineers
- Limited authority of design team members in design and build to instruct contractors (who are paying them and may be their main potential sources of future work) to redo non-compliant work. Snagging discouraged or even excluded.
- Failure to have professional sign-off of changes to design or substitution of materials by main and sub-contractors prior to their implementation on site
- No direct relationship between client and design team with regard to assurances as to the quality of construction being carried out or it complying with design

INCREASING MARGINALISATION OF DESIGN TEAM IN CURRENT CONTRACTS

- Design team functions increasingly being marginalised to pre-construction office-based activities
- The essential golden thread between design and implementation of that design on site has become increasingly frayed and frequently totally severed. Professional knowledge is increasingly absent from decision-making on site
- Little point in having approved sets of building regulations compliant drawings if there is no assurance that what is designed is actually built
- Designers frequently unable to ensure that the underlying design intent is being delivered
- Number of visits by Building Control Inspectors usually inadequate to provide more than a very limited spot check of compliance
- Reluctance to ask for opening up of already enclosed and previously unobserved work due to having to meet cost if found to be compliant

DESIGN TEAM ISSUES

- Design teams cutting back on production of documentation with more design responsibility being transferred to contractors / sub-contractors potentially compromising the interdependence of elements in the original design and lacking a holistic oversight of the total design by the designers
- Reduced site visits / site presence by design team members leading to a gradual deskilling of younger members of the professions in the knowledge and practicalities of materials and on-site construction
- A significant reduction in the use, training of and availability of experienced clerks of works as the eyes and ears of the design team in protecting the client's interests and in their ability to issue instructions
- Contractors increasingly determining level of fees to be paid; the scope of appointments; selection of design team members, and the level of involvement of design team members in site inspections, if any!
- Design team members in D&B often contractually prevented from reporting defective work to the real client and potentially being overruled by site managers with potential conflicts of interest

ENSURING THE QUALITY AND SAFETY OF CONSTRUCTION

- The desire to cut construction costs has often resulted in cutting the cost of protecting quality through reduction in fees and the services traditionally provided by design teams
- It is a fundamental role of clients in any contract, and particularly in public sector contracts, to ensure that the product as built is to the specified design and standards
- Evidence has shown that it is not sufficient to rely on self-certification by contractors as to the quality of buildings built by themselves
- There has been a naive over-reliance placed by many clients on the existence of contractors' paper-based quality assurance systems
- Evidence would show that independent expert scrutiny is required on site on an on-going basis during construction from clerks of works, and where appropriate resident engineers and architects
- Those best placed to ensure that buildings are in accordance with approved designs are those who designed them and fully understand the design intent. Their authority to do so is increasingly being removed

Some conclusions from Edinburgh Schools Inquiry as to the role of lack of adequate independent scrutiny

1. It is the unequivocally held view of the Inquiry that **there were fundamental and widespread failures of the quality assurance processes of the various contractors and sub-contractors, who built or oversaw the building of the PPP1 schools**, to identify and rectify both defective construction of the cavity walls and the omission of the proper incorporation of required restraints and secondary steelwork.
2. The Inquiry is of the view that **it was insufficient for public sector clients, with a responsibility to protect the safety of the communities they serve, to so largely rely on the quality assurance processes of contractors for confirmation that key aspects of the building impacting on the safety of users have been properly constructed. An appropriate level of professional independent scrutiny was missing.**
3. From evidence provided to the Inquiry, it was clear, however, that **assumptions were made by the Council and other parties regarding the level of assurance one could place on the quality of construction as a result of the role undertaken by Independent Certifiers.**
4. Edinburgh Council, in common with probably a significant majority of public sector clients in Scotland over recent years, **did not appoint Clerks of Works to provide inspection services on the PPP1 schools.**
5. The Inquiry formed the view that **there was a common misconception, even among some Council officers, as to the extent of the reliance that can be placed on the quality of construction of a building because it had successfully gone through the statutory Buildings Standards process and inspections.**

THE LIST OF RECOMMENDATIONS OF THE EDINBURGH INQUIRY

- The collapse of the wall at Oxfangs a symptom of a broader problem within the Industry.
- List of 40 recommendations were published in the Report. These extended beyond defects in masonry construction and fire-stopping requiring action by Government, public sector clients, the building professions, client advisors and design teams, contractors, sub-contractors and tradesmen, and education and training bodies. The Report is available on the CEC web-site.
- The 40 individual recommendations were listed under the following nine sub-headings:
 1. Procurement
 2. Independent Certifier
 3. Client's Relationship with the Design Team
 4. Information Sharing
 5. Construction
 6. Training and Recruitment
 7. Building Standards
 8. Sharing of Information
 9. Recommendations for the City of Edinburgh Council
 - 10 Further Inspections

Scottish Procurement Construction Policy Note CPN 1/2017

20 July 2017

Interim guidance for site inspection and assurance on behalf of public sector clients

Purpose

1. This construction policy note provides an update and interim guidance following the publication of the Report of the Independent Inquiry into the Construction of Edinburgh Schools (the Report).

Construction quality monitoring

15. As identified by the report it is important for public sector clients to maintain an appropriate level of independent oversight of building projects to ensure the quality of the works meets the specification and standards whatever form of construction contract or procurement strategy is used.

OTHER ACTIONS BY THE SCOTTISH GOVERNMENT

- Series of industry-wide Ministerial summits including public sector bodies seeking a planned programme of initiatives aimed at improving quality
- All Local Government bodies required to advise how they are addressing recommendations of the Inquiry Report
- Review of performance of Local Government Bodies as Building Standards Verifiers and reduced periods for renewal of accreditation for poor performance
- Review of the effectiveness of the statutory building control system as currently applied in relation to ensuring compliance with and enforcement of the regulations
- Review of the building standards regulations in relation to fire

POTENTIAL CONTRIBUTORY FACTORS RAISED IN EVIDENCE TO THE INQUIRIES

CONTRACTOR ISSUES:

- A culture that is over-focussed on cost and time often to the detriment of quality
- Reduction in main contractor's managerial site staff with hands-on knowledge of building trades
- Insufficient specialist supervisory staff on site
- Main contractors no longer training or employing young apprentices with loyalty to the company
- More tradesmen as self-employed sub-contractors moving from project to project for best earning
- The on-going squeezing of sub-contractors for lowest prices often resulting in lowest quality
- Wide spread evidence of failures of paper-based box ticking rather than site observation-based quality inspections
- Discouraging or not employing D&B design teams to inspect or properly snag projects
- Removing defective or non-compliant creates a conflict of interest work due to commercial factors /performance pay based on time and construction cost targets not quality

POTENTIAL CONTRIBUTORY FACTORS RAISED IN EVIDENCE TO THE INQUIRY

PRICING AND SITE ISSUES

- Labour only / Labour and materials as basis for pricing without proper specification or quantification of materials required to be supplied and/or installed; in Edinburgh brickwork accessories
- Limited information frequently provided to sub-contractors during bidding particularly in design and build when detailed design often follows architectural design
- Subsequent push by contractors/sub-contractors to designers to reduce cost by reducing level of requirement; in Edinburgh a real issue in relation to brick accessories
- Contractors not knowing or checking that those on site are actually qualified tradesmen. Card system focused on health and safety rather than occupational qualifications
- Poor level and format of information given to tradesmen. Evidence suggested frequently only elevations provided to bricklayers and limited awareness by bricklayers of key role of brick accessories.

POTENTIAL CONTRIBUTORY FACTORS RAISED IN EVIDENCE TO THE INQUIRY

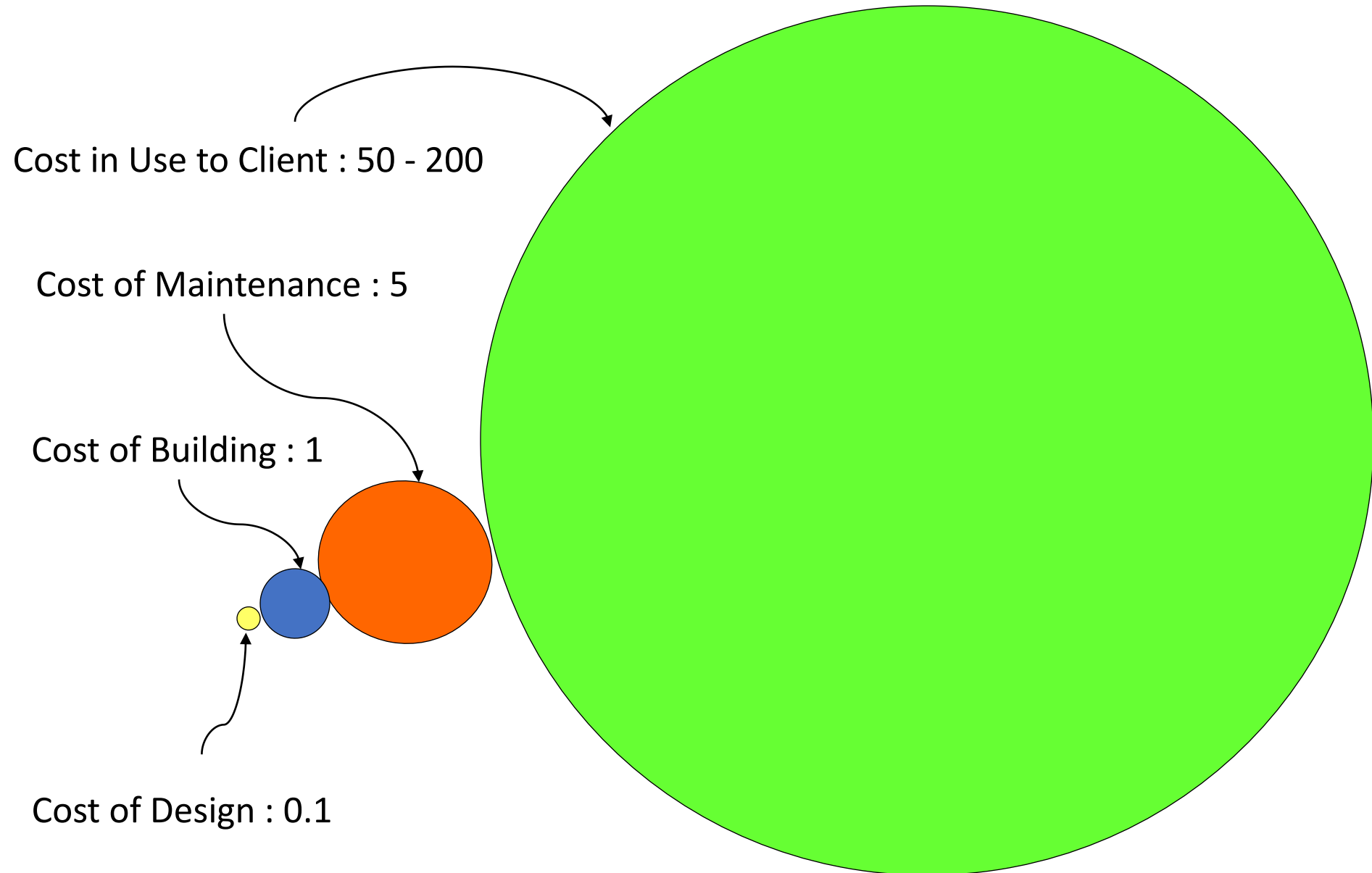
PRICING AND SITE ISSUES (cont.)

- Pay systems based on quantity not quality e.g. number of bricks / blocks laid. No extra pay for taking care with brick accessories the fitting of which slow bricklaying and reduce earning potential.
- Unfitted head restraints left sitting / hidden on flanges of steel beams rather than being fitted
- Several accounts of labour only bricklayers continuing to build walls when wall-ties have run out
- Commercial benefit of building inner leaf overriding creation of practical problems of cavity width/ coursing/ embedment/ verticality
- Difficult for site supervisors to check proper embedment of wall ties or inclusion of header and lateral ties after wall is closed in.

SOME RECOMMENDATIONS FROM BUILDING STANDARDS REVIEW

- Changing the focus of Building Standards Depts resources from primarily office based drawing checking roles to ensuring that what is built on site complies with approved drawings and with the regulations.
- A requirement for the construction of larger/higher risk projects to be professionally certified as compliant by a registered professional independent from the contractor before the submission of a completion certificate for acceptance by Building Standards
- A detailed testing, proving, inspection and documenting regime should be established. This should include the preparation of an overall Compliance Plan to be supported by a Contractors Inspection and Testing Plan and a Construction Compliance Evidence Documentation file.
- A requirement for clients to require from their design and construction teams a pre-determined range of required certified Evidence of Construction Compliance prescribed in advance of construction on a project by project basis by Building Standards who would subsequently audit check this.
- Dated digital video / photo recordings to an agreed format should be made a standard requirement especially for areas of work to be closed in.

IMPACT OF DESIGN ON LIFE-COSTS



CONCLUDING THOUGHTS

- There is a need for a fundamental change of culture within our Industry to improve its focus on quality of product. Until that new culture is embedded effective independent scrutiny and regulation of construction is essential
- An appreciation of the ongoing value of design excellence in the built environment on the quality of life for all and an understanding of the potential tragic consequences for communities of sub-standard design and construction
- A focus on greater efficiency in delivering the required quality rather than cutting quality to achieved reduced costs through frequently misdirected 'value-engineering' processes
- A focus on developing a work-force with the requisite management and operational skills to meet the needs of a changing industry and a re-professionalism of the Industry
- Time and cost while important are short-term objectives, excellent design and construction quality endures and goes on and on giving when time and cost are long forgotten



‘The unacceptable and unrepeatable cost of cutting quality in construction’



‘Quality endures and goes on and on giving’