Low carbon Built Environment

Aberdeen 27th January 2011

Technical Considerations for Construction Products

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Agenda

- Historical Context
- Performance Requirements
- Structural Performance
- Fire Performance
- Other Performance Considerations
- CE Marking
- Low Carbon?
- Product Development Cpnsideration

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Historical Context

Building Regulations

- Long history of legal controls on building construction
- It all began in London.
  - Densely-packed housing
  - Rights to light
  - Noise and nuisance
  - Location of privies and gutters
- First set of regs 1189
- The greatest hazard was fire. After a major fire in 1212, thatched roofs were banned.
- Great Fire of London in 1666, wiped out **80%** of the city. This led to the London Building Act of 1667, the first to provide for surveyors to enforce its regulations. It laid down that all houses were to be built in brick or stone. The number of storeys and width of walls were carefully specified. Streets should be wide enough to act as a fire break
- The Building Acts of 1707 and 1709 extended that control to Westminster. A comprehensive Act in 1774 covered the whole built-up area.

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- In the early Victorian period central government became concerned about the conditions of the urban poor. Outbreaks of cholera were common
- It was a series of Public Health Acts that established a more consistent apparatus for controlling the urban fabric. The first such Act in 1848 had limited impact on buildings, but laid out the framework of local authority in England and Wales, known initially as boards of health.
- The Act of 1858 permitted local boards in England and Wales to require the deposit of plans for any new buildings or alterations.
- The Public Health Act in 1936 brought in new model bye-laws
- The Public Health Act of 1961 was the statutory instrument and the first regulations were published in 1965. They came into operation in February 1966 throughout England and Wales, apart from the Inner London Boroughs.

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Scottish Building Standards

- In Scotland each medieval burgh operated a Dean of Guild Court, which dealt with rights of access and nuisances. So when the burghs began to develop building regulations in the 17th century, they fell within the remit of the Dean of Guild Court.

- After Edinburgh suffered a series of fires, an Act of the City Council in 1674 gave the Court authority to enforce new building regulations, ratified in 1698 by an Act of the Scottish Parliament. Among other things it restricted buildings to five storeys.

- In Scotland the Dean of Guild Courts became almost exclusively concerned with building regulation in the Victorian era and continued in that role until their abolition in 1975. After 1897 they too required plans to be submitted to them.

- Scotland was the first country in the United Kingdom to adopt national regulations. The Building (Scotland) Act in 1959 created the power to do so. The first set of Building Regulations was published in 1963 and came into force in 1964.

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Performance Requirements

Performance Requirements

- This is a risk driven industry with major changes driven by failure
- There are minimum standards within any product category
- The minimum standards are generally set out in Building Regulations
- The market is specifier led, based on meeting the minimum standards, if you cant meet these the product will fail
- Construction products directive is leading standards development
- Testing is normally required to show compliance
  - It takes time
  - It can be expensive

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Example - Building Systems and MMC

- Typical requirements
  - UK Building Regulations for Safety and functionality
  - Buildability
  - Durability
  - Resilience
  - Repairability
  - Whole life performance
  - Adaptability
  - Guidance on installation and maintenance
  - Factory production control system

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Building Standards

- **Section1: Structure**
- 1.1 Structure
- 1.2 Disproportionate collapse
- 1A Structural design Standard

- **Section 2: Fire**
- 2.1 Compartmentation
- 2.2 Separation
- 2.3 Structural protection
- 2.4 Cavities
- 2.5 Internal linings
- 2.6 Spread to neighbouring buildings
- 2.7 Spread on external walls
- 2.8 Spread from neighbouring buildings
- 2.9 Escape
- 2.10 Escape lighting
- 2.11 Communication
- 2.12 Fire and Rescue service access
- 2.13 Fire and rescue service water supply
- 2.14 Fire service facilities
- 2.15 Automatic fire suppression systems
- 2.A Resistance to fire
- 2.B Reaction to fire
- 2.C Vulnerability of roof coverings

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- **Section 3: Environment**
- 3.1 Site preparation harmful and dangerous substances
- 3.2 Site preparation – protection from radon gas
- 3.3 Flooding and ground water
- 3.4 Moisture from the ground
- 3.5 Existing drains
- 3.10 Precipitation
- 3.11 Facilities in a dwelling
- 3.12 Sanitary facilities
- 3.13 Heating
- 3.14 Ventilation
- 3.15 Condensation
- 3.16 Natural lighting
- 3.17 Combustion appliances – safe operation
- 3.18 Combustion appliances – protection from products of combustion
- 3.19 Combustion appliances – relationship to combustible materials
- 3.20 Combustion appliances – removal of products of combustion
- 3.21 Combustion appliances – air for combustion
- 3.22 Combustion appliances – air for cooling

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- **Section 4: Safety**
- 4.1 Access to buildings
- 4.2 Access within buildings
- 4.3 Stairs and ramps
- 4.4 Pedestrian protective barriers
- 4.5 Electrical Safety
- 4.6 Electrical fixtures
- 4.7 Aids to communication
- 4.8 Danger from accidents

- **Section 5: Noise**
- 5.1 Noise Separation
- 5.2 Noise reduction between rooms

- **Section 6: Energy**
- 6.1 Carbon Dioxide emissions
- 6.2 Building insulation envelope
- 6.3 Heating system
- 6.4 Insulation of pipes, ducts and vessels
- 6.5 Artificial and display lighting
- 6.6 Mechanical ventilation and air conditioning
- 6.9 Energy Performance Certificate

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What’s so different from traditional build?

- There is a history of failure from MMC (Circa. 4 million non trad’s defective in UK)
- Reluctance from Insurance, warranty and lending industries to support Non traditional construction techniques
- The onus is on the system manufacturer to show performance compliance
- System manufacturer to collect and assess relevant information from supply chain
- Testing of completed structure to satisfy
- One failed component could lead to product failure

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Structural Performance

Structural performance

- Design dead and imposed loads should be determined using BS 6399: Parts 1and 3, or BS EN 1991-1-1, BS 1991-1-3, BS EN 1991-1-5: and BS EN 1991-1-7

- Design wind loads shall be determined using BS 6399:Part 2 or BS EN 1991-1-4 taking appropriate account of location-related effects. Wind loads may be calculated either for specific locations or based on a stipulated maximum value which may then limit the locations where the building can be sited in the UK.

- The design of systems should be carried out by a qualified structural engineer in accordance with relevant material and structural standards. Where this is not possible, owing to the absence of appropriate standards, then design shall be based on sound engineering principles supported by appropriate technical data.

- **Verification by Testing -** The design of systems may be assisted by testing in which case the appropriate sections of relevant material and structural standards and/or BS EN 1990 should all be used.

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Structural performance - Typical standards

- **BS 585–2:1985** Wood Stairs. Specification for performance requirements for domestic stairs constructed of wood-based materials
- **BS 5268-2:2002** Structural use of timber. Code of practice for permissible stress design, materials and workmanship
- **BS 5268-3:1998** Structural use of timber. Code of practice for trussed rafter roofs
- **BS 5268-4.1:1978** Structural use of timber. Fire resistance of timber structures. Recommendations for calculating fire resistance of timber members
- **BS 5268-4.2:1990** Structural use of timber. Fire resistance of timber structures. Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions
- **BS 5268-5:1989** Structural use of timber. Code of practice for the preservative treatment of structural timber
- **BS 5268-6.1:1996** Structural use of timber. Code of practice for timber frame walls. Dwellings not exceeding four storeys
- **BS 5268-6.2:2001** Structural use of timber. Code of practice for timber frame walls. Buildings other than dwellings not exceeding four storeys
- **BS 5268-7.1:1989** Structural use of timber. Recommendations for the calculation basis for span tables. Domestic floor joists
- **BS 5268-7.2:1989** Structural use of timber. Recommendations for the calculation basis for span tables. Joists for flat roofs
- **BS 5268-7.3:1989** Structural use of timber. Recommendations for the calculation basis for span tables. Ceiling joists

Structural performance - Typical standards

- **BS 5268-7.4:1989** Structural use of timber. Ceiling binders
- **BS 5268-7.5:1990** Structural use of timber. Recommendations for the calculation basis for span tables. Domestic rafters
- **BS 5268-7.6:1990** Structural use of timber. Recommendations for the calculation basis for span tables. Purlins supporting rafters
- **BS 5268-7.7:1990** Structural use of timber. Recommendations for the calculation basis for span tables. Purlins supporting sheeting or decking
- **BS 5950-1:2000** Structural use of steelwork in building. Code of practice for design. Rolled and welded sections
- **BS 5950-2:2001** Structural use of steelwork in building. Specification for materials, fabrication and erection. Rolled and welded sections
- **BS 5950-3.1:1990** Structural use of steelwork in building. Design in composite construction. Code of practice for design of simple and continuous composite beams
- **BS 5950-4:1994** Structural use of steelwork in building. Code of practice for design of
- composite slabs with profiled steel sheeting
- **BS 5950-5:1998** Structural use of steelwork in building. Code of practice for design of cold formed thin gauge sections

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Structural performance - Typical standards

- **BS 5950-6:1995** Structural use of steelwork in building. Code of practice for design of lightgauge profiled steel sheeting
- **BS 5950-7:1992** Structural use of steelwork in building. Specification for materials and workmanship: cold formed sections
- **BS 5950-8:2003** Structural use of steelwork in building. Code of practice for fire resistant design
- **BS 5950-9:1994** Structural use of steelwork in building. Code of practice for stressed skin design resistance of non-load bearing elements of construction
- **BS 6180: 1999** Barriers in and about buildings. Code of practice
- **BS 6399-1:1996** Loading for buildings. Code of practice for dead and imposed loads
- **BS 6399-2:1997** Loading for buildings. Code of practice for wind loads
- **BS 6399-3:1988** Loading for buildings. Code of practice for imposed roof loads
- **BS 8110-1:1997** Structural Use of Concrete Part 1 Code of Practice for design and construction
- **BS 8110-2:1985** Structural Use of Concrete Part 2 Code of Practice for special circumstances

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Fire Performance

Fire Performance

- **Reaction to fire of internal linings and products**
  - The manufacturer should design the Reaction to Fire performance in accordance with either:
    - *Results of test methods to BS 476: Parts 4 and 11 and/or BS 476: Parts 6 and 7 or*
    - *European fire test methods to derive a classification in accordance with BS EN 13501-1, or.*
    - *Assessment based on BS 476: Parts 4 and 11 and/or Parts 6 and 7 (see Section 2.0).*

- **Fire resistance of structural or separating elements including cavity barriers**
  - Where compartmentation, which separates buildings or occupancies, has openings such as doors or pipe penetrations, the manufacturer shall design the fire resistance of the separating element in accordance with either:
    - *Results of testing in accordance with BS 476 Parts 20-24 or the European fire resistance classification in accordance with BS EN 13501-2 employing the relevant EN test methods, or*
    - *Assessment based on BS 476: Parts 4 and 11 and/or 6 and 7 (see Section 2.0).*

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Fire Performance

- **Junction of compartment wall or compartment floor with other walls**
  - Where a compartment wall or a compartment floor meets another compartment wall, or an external wall, the manufacturer shoud design that junction to maintain the fire resistance of the compartmentation in order to allow the maximum period of fire resistance required by an element to be achieved.

- **External fire spread on walls and roofs**
  - The design should meet external fire spread performance in accordance with either:
    - *Results of tests in accordance with BS 476: Part 3 or BS EN 13501 Part 5 for roofing or, if appropriate, BS 8414 for external cladding systems, or*
    - *Assessment for roofing based on BS 476: Part 3 only (see Section 2.0).*

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Fire Performance - Typical standards

- **BS 476-3:2004** Fire tests on building materials and structures. Classification and method of test for external fire exposure to roofs
- **BS 476-4:1970** Fire tests on building materials and structures. Non-combustibility test for
- Materials
- **BS 476-6:1989** Fire tests on building materials and structures. Method of test for fire
- propagation for products
- **BS 476-7:1997** Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products
- **BS 476-11:1982** Fire tests on building materials and structures. Method for assessing the heat emission from building materials
- **BS 476-20:1987** Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
- **BS 476-21:1987** Fire tests on building materials and structures. Methods for determination of
- the fire resistance of load bearing elements of construction
- **BS 476-22:1987** Fire tests on building materials and structures. Methods for determination of
- the fire resistance of non load bearing elements of construction
- **BS 476-23:1987** Fire tests on building materials and structures. Methods for determination of
- the contribution of components to the fire resistance of the structure

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Fire Performance - Typical standards

- **BS 476-24:1987** Fire tests on building materials and structures. Methods for determination of
- the fire resistance of ventilation ducts
- **BS 8414-1:2002** Fire performance of external cladding systems Part 1: Test Method for no load bearing external cladding systems applied to the face of the building.
- **BS EN 1365-1:1999** Fire resistance tests for load bearing elements. Walls
- **BS EN 1365-2:2000** Fire resistance tests for load bearing elements. Floors and roofs
- **BS EN 1365-3:2000** Fire resistance tests for load bearing elements. Beams
- **BS EN 1365-4:1999** Fire resistance tests for load bearing elements. Columns
- **BS EN 13501-1:2007** Fire classification of construction products and building elements, Part 1 – Classification using data from reaction to fire tests
- **BS EN 13501-2: 2003** Fire classification of construction products and building elements, Part 2 – Classification using data from fire resistance tests (excluding products for use in ventilation systems)
- **BS EN 13501-5: 2007** Fire classification of construction products and building elements, Part 5 – Classification using data from external fire exposure to roofs tests

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Other Performance Considerations

Other Considerations

- **Weathertightness**
  - Determine the risk of interstitial condensation for each element in accordance with BS EN ISO 13788 and BS 5250.
  - Demonstrate vapour permeability and moisture resistance through results of testing carried out to BS EN 12086
- **Safety in Use**
  - determine the design loads appropriate to occupancy and use from BS 6399 Part 1 or BS EN 1991-1-1. The design of elements and components should be in accordance with the relevant material and performance standards e.g. BS 6180 for barriers, BS 585 and/or BS 5395 for stairs, or based on established product performance for that use. For the latter, the manufacturer shall supply relevant product data. **Sound insulation**
- Acoustic performance
  - Demonstrate compliance by use of appropriate Robust Details (RD) or by details substantially similar to and of equal performance or better. If no RD solutions exist, then the manufacturer should undertake testing in accordance with BRE Certification Guidance Document GD021 – *Sound Insulation Performance Requirements to Approved Document E (2003 Edition): BRE Certification Evaluation of Performance by Testing*.

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Durability, Resilience, Materials and Workmanship

- The life expectancy of the structural system and inaccessible elements of components **should not be less than 60 years**.
- Individual elements or components with shorter life expectancies should be identified in the installation and/or user manual(s) and their life expectancies stated, taking into consideration appropriate maintenance, refurbishment and/or replacement schedules
- The durability, resilience and repairability of building systems should be assessed against a benchmark residential building constructed using an established method of building.

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Energy Economy and Heat Retention

- The manufacturer should demonstrate compliance of the thermal performance of buildings, in accordance with the procedures given in the Building Regulations/Standards which, involves the use of approved calculation tools
- Undertake element U-value calculations in accordance with the following:
  - • Walls and roofs: BS EN ISO 6946
  - • Ground floors: BS EN ISO 13370
  - • Windows and doors: BS EN ISO 10077-1 or BS EN ISO 10077-2
  - • Basements: BS EN 13370 or the BCA/NHBC Approved Document
  - • Light steel-frame construction: Digest 465, BRE 2002
  - • Components outside the scope of the above: BS EN ISO 10211-1.
- The manufacturer should consider evidence to show that the connections between elements of the building system comply with the regulatory requirements. This could be via the use of published Robust Construction Details or by appropriate modelling
- Consider testing to the following standards:
  - BS EN 12664, BS EN 12667 or BS EN 12939 for thermal conductivity
  - BS EN ISO 8990 for thermal transmittance
  - BS EN ISO 12567-1 for thermal transmittance of windows and doors.

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Practicability of Installation (Buildability).

- The manufacturer should provide a set of clear instructions detailing the assembly and installation for the system as appropriate. These instructions shall cover factory and site assembly as required.
- The construction of the system should be in accordance with the relevant manufacturer's instructions using an appropriately trained or qualified workforce.
- The manufacturer should provide a checklist detailing the critical assembly and installation checks for the system, as required, for inspection of on-site construction and quality control by Building Control and/or other appropriate organisations.
- The installation instructions should include specifications for the tolerances of
- ancillary constructions to be provided by others, e.g. foundation levels, so as not to impair the construction of the building.
- The building should be made weathertight as soon as practicably possible during construction in order to protect elements and components that may be damaged by water.

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CE Marking

CE Marking

- The letters "**CE**" are the abbreviation of French phrase "**C**onformité **E**uropéene" which literally means "European Conformity". The term initially used was "EC Mark" and it was officially replaced by "CE Marking" in the Directive 93/68/EEC in 1993. "CE Marking" is now used in all EU official documents.

  "CE Marking on a product is a manufacturer's declaration that the product complies with the **essential requirements** of the relevant European health, safety and environmental protection legislation"
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  - ***Product Directives** contains the "essential requirements" and/or "performance levels" and "Harmonized Standards" to which the products must conform. Harmonized Standards are the technical specifications (European Standards or Harmonization Documents) which are established by several European standards agencies (CEN, CENELEC, etc).**CEN** stands for European Committee for Standardization.
  - CE Marking on a product indicates to governmental officials that the product may be **legally placed on the market** in their country.
  - CE Marking on a product ensures the **free movement of the product** within the EFTA & European Union (EU) single market (total 28 countries), and
  - CE Marking on a product permits the **withdrawal of the non-conforming products** by customs and enforcement/vigilance authorities.

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Construction Products, which need CE-marking

- Admixtures for concrete, mortar & grout
- Aggregates
- Building hardware
- Building lime
- Cements
- Chimneys
- Curtain walling
- External thermal insulation composite systems/kits with rendering (ETICS)
- Fire detection and fire alarm systems
- Fixed firefighting systems

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Construction products, which need CE-marking

- Geotextiles
- Industrial and garage doors
- Lighting columns
- Masonry mortar
- Masonry units
- Metal anchors for use in concrete or masonry
- Roof waterproofing membranes
- Screed material and floor screeds
- Structural bearings
- Suspended ceilings
- Thermal insulating products
- Wood-based panels

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CE-Marking

- is **not** a **quality mark**
- is **not** a **mark showing conformity with standards**
- is **not** a **certification mark**, **therefore it cannot be licensed or withdrawn**
- has a **single meaning, i.e. the compliance with legal provisions**
- stands for **different contents, depending on the topic of the respective EU-Directive**

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Low Carbon?

- What are you measuring
  - Process
  - Embodied
  - In use
- What are you comparing against
- Is this measured on a like for like basis
- Is it verified through testing
- Is it verified independently

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LCBE- Product Development Considerations

- What is the product for?
- What are the minimum performance standards for a product of this type for:
  - Structural performance
  - Fire performance
  - Environmental performance
  - H&S requirements
- Can we show compliance
- Can we show and audit a Carbon saving
- What are the product drivers

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Questions

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