IBCI Conference

Newmarket on Fergus
21st March 2018

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Building Control Officer

Mayo County Council

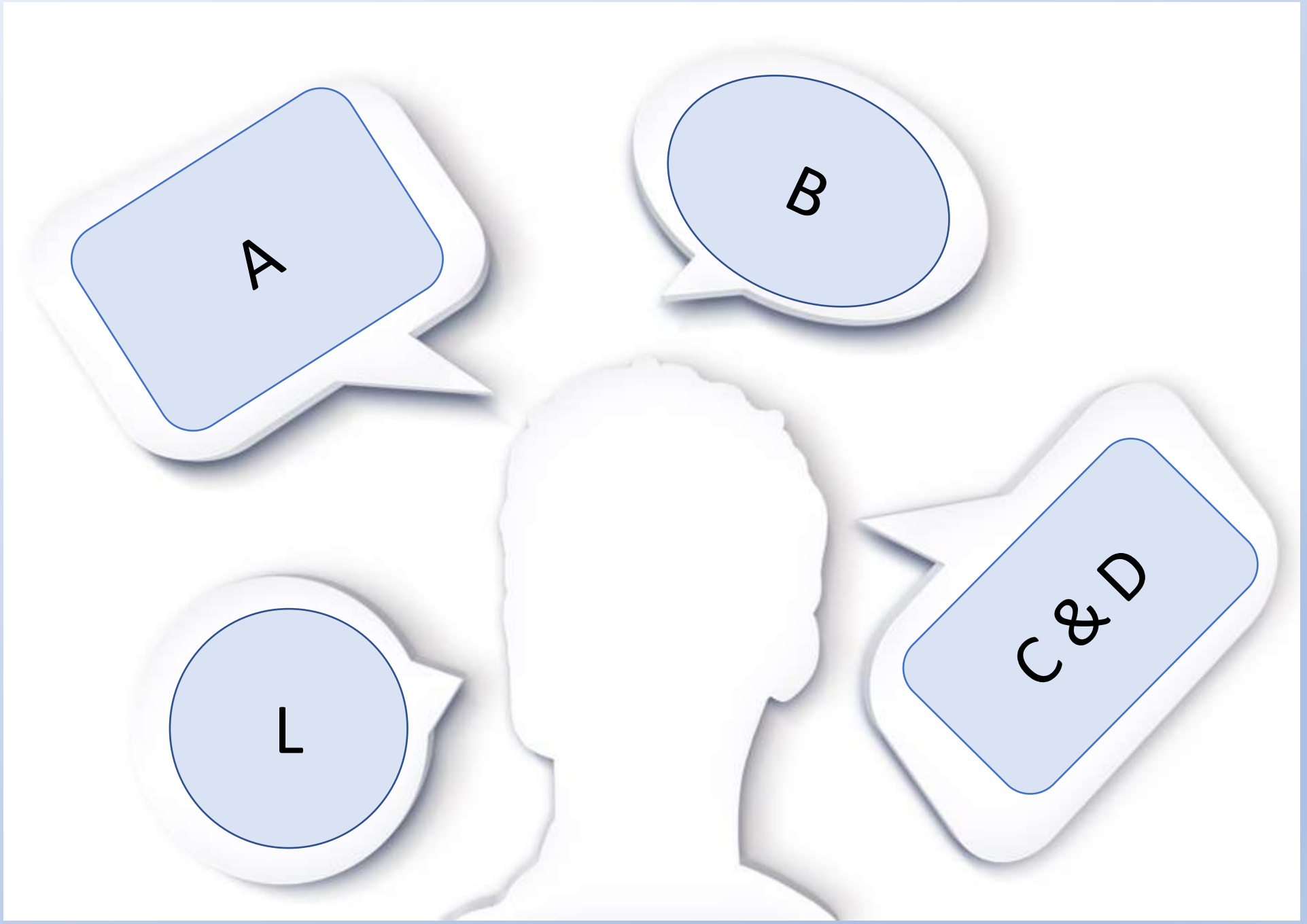
Compliance with Building Regulations

Where works are carried out in accordance with the Technical Guidance Documents, this will, prima facie, indicate compliance with the Second Schedule of the Building Regulations.

Those involved in the design and construction of a building may be required by the relevant building control authority to provide such evidence as is necessary to establish that the requirements of the Building Regulations have been complied with.

Complaint

- Extension to house
- Not in compliance with Building Regulations
- Straw bale method of construction



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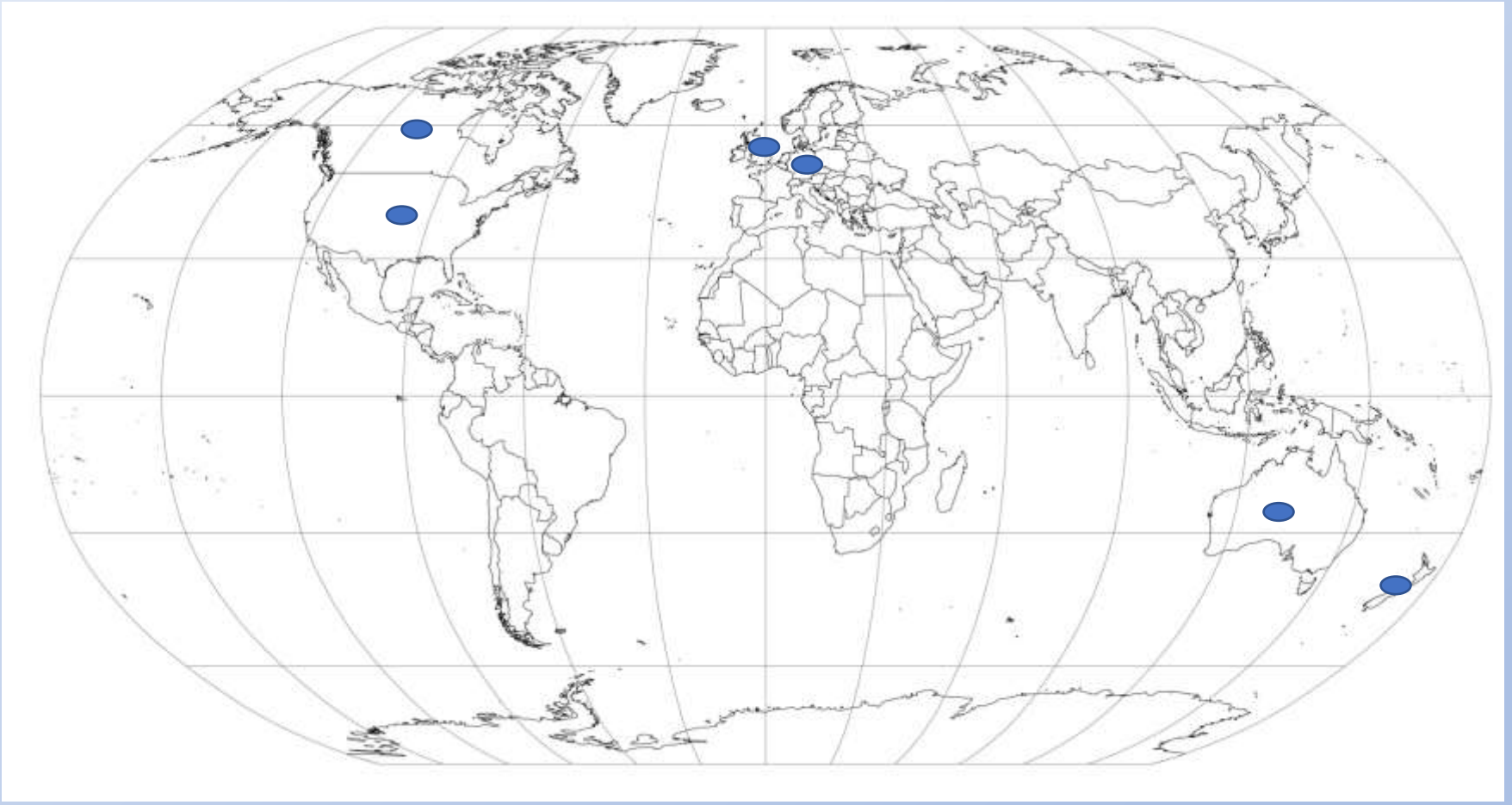
History

- First constructed in the US in the late 1800s on the plains of Nebraska
- White settlers in an area without building stone or timber
- Built temporary houses out of what was, to them, a waste material
- Built with the bales forming the loadbearing structure (Nebraskan style)
- Warm throughout the very cold winter yet cool during the hot summer
- Soundproofing benefits of protection from the howling winds
- Flourished until about 1940 - rise in the popularity and use of cement

Information



UK	Germany	Australia
New Zealand	USA	Canada

IRC Appendix R - Bales

- Rectangular in shape
- Minimum height and thickness of 305mm.

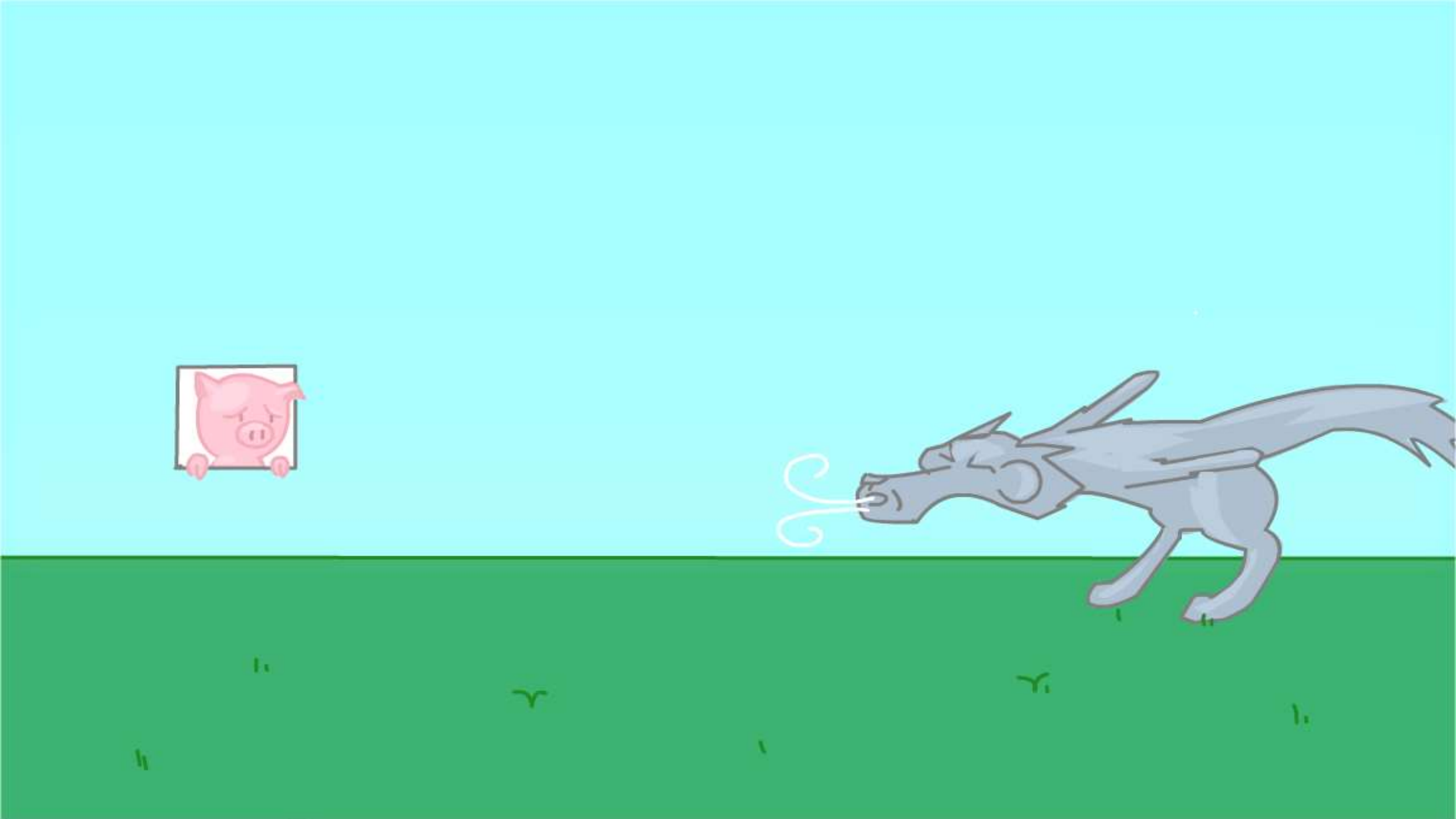
  (tend to be typically 1000 * 460 * 375mm)
- Tie requirements

  (type of tie wire and spacing from the outer edges)
- Maximum moisture content of 20% of the weight of the bale

  (at the first coat of plaster or the installation of another finish)
- Minimum dry density of 104Kg/m3
- Composed of straw from wheat, rice, rye, barley or oat, or other approved.

Construction Methods

- Loadbearing (Nebraska)
- Infill (Post & Beam/Timber Frame
- Prefabricated Straw Bale Walls



Loadbearing - (Nebraska)

- Big straw blocks on the base plate
- Windows/doors inside structural box frames which float within the straw or fixed to foundation below using fixing posts.
- Bales take the weight of the roof
- Wooden roof plate on top
- Roof is constructed in the usual manner

Loadbearing - (Nebraska)

- May or may not fasten mesh to the straw surfaces

  May tie through the wall to the far side.

  May fasten it very well or very lightly

- Test reports on their loading, creep, deformation and stiffness

IRC Code - Loadbearing

- One storey buildings
- Voids max 102mm stuffed with straw flakes or clay-straw
- Minimum compressive strength of plasters specified
- Allowable bearing capacity of walls specified
- Pre compression of walls before plastering

Non-Loadbearing
(Post and Beam/Timber Frame)

- Frame takes the weight of the roof and transfers it to the foundation
- Bales are infill insulation blocks between the posts
- More traditional structural design and certification
- Often preferred option for Engineers/Architects/Building Control

IRC Code – Non-Loadbearing

- One storey buildings (or 2 with approved engineered design)
- Max Building height 7.62m
- Wall height limitations based on wind speeds, seismic design categories

Roof

- Roof design typically follows the format of a traditional house.

- A large overhang is a typical feature of such buildings

  Especially in more exposed climates/areas.

Fire -USA

- The Ecological Building Network
  Two fire resistance tests of straw bale walls in 2006
  Intertek Testing Services

- Tests conducted according to ASTM 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

Fire -USA

- 1-hour fire resistance test of a non-loadbearing straw bale wall with 2 coats earth plaster 13mm thick each applied to each side

- Sample wall was 4.25 m wide and 3.65 m high
  Bales were 915mm L, 460mm W, 355mm H
  Tightened by two polypropylene ties

Fire -USA

1-hour fire resistance test

Wall withstood the fire without passage of flame or gases hot enough to ignite cotton pad (Integrity) and that transmission of heat through the wall during the test did not raise the average temperature on the unexposed surface more than 121 ºC, nor any individual temperature more than 163 ºC (Insulation).

Test report declared the specimen to have fire resistance of 60 minutes.

Fire -USA

2-hour fire resistance test of a non-loadbearing straw bale wall with galvanized stucco mesh and 2 coats cement stucco plaster 13mm thick each applied to each side

Sample wall was 4.25 m wide and 3.65 m high

Bales were 915mm L, 460mm W, 355mm H

Tightened by two polypropylene ties

Fire -USA

2-hour fire resistance test

Wall withstood the fire without passage of flame or gases hot enough to ignite cotton pad (integrity) and transition of heat through the wall during the test did not raise the average temperature on the unexposed surface more than 121 ºC, nor any individual temperature more than 163 ºC (Insulation).

Test Report declared the specimen to have fire resistance of 120 minutes.

Fire - UK

Bath University

Chiltern International Fire carried out a fire resistance test of a prefabricated straw bale panel in 2009

Test conducted in accordance with BS EN 1364-1: 1999 (Fire resistance tests for non-loadbearing elements. Walls).

Fire - UK

Sample wall was 3.00m wide and 3.00m high

Bales were 943mm L, 450mm W, 350mm H

Tightened by two ties

Fitted into a frame and plastered using 30mm thick Limetec basecoat lime render on each face.

Fire - UK

Temperature within the furnace reached an average of 1065°C at 135 min

Temperatures monitored on the outer surface of the panel started at 12–14°C and raised to 36–60°C

The panel was removed after the test was stopped, hosed down and inspected.

- Straw exposed to the furnace had charred black
- On the outer side, once render was removed, yellow straw was still visible.

Fire - Germany

Fachverband Strohballenbau Deutschland e.v.

MPA Braunschweig carried out a test on a straw bale wall rendered with clay plaster in 2008

Test conducted in accordance with EN 13501-1: 2007.

Wooden frame with straw bales rendered with 8mm thick clay plaster with an overall wall thickness of 500mm.

Fire - Germany

The wall was classified as B-s1, d0.

Under TGD B 2017 the surface linings of walls and ceilings in rooms and circulation spaces should meet

Class C – s3, d2 criteria.

Moisture - Timber

Timber Frame Housing Consortium report 2002:

“When kept at a moisture content below 22% timber will exceed the 60-year life expectancy required for buildings given in BS 7543: 1992. However, if timber is subjected to an environment where its moisture content may rise above 22%, e.g. as a result of poor workmanship, the failure of a cladding system or poor detailing around openings, then it may suffer from fungal decay.”

Moisture - Timber

It goes on to say that

“Extensive research of completed houses carried out by TRADA shows that after about two years, the moisture content of timber studs within a properly completed wall is around 14% …….

……... Fungal decay will only occur when timber is in prolonged contact with the ground, damp masonry or other damp conditions, which raise its moisture content above 22%.”

Moisture - Timber

I.S. 440:2009+A1:2014 requires:

“The moisture content of the solid timber (when measured in accordance with I.S. EN 13183-2) at the time of fabrication and/or delivery shall not exceed 18 %”.

Moisture - Straw

University of Bath

In tests carried out on a prototype house between September 2009 and July 2010, the average daily timber moisture contents did not exceed 22%.

Moisture - Straw

University of Oslo

7 of 8 monitored sensors had moisture levels below 20 %
This is below the level associated with the start of degradation of timber and straw.

1 sensor placed in one severely exposed wall did record moisture contents of 25% for a period of several months.

This shows how crucial proper design and protection from moisture is in straw bale buildings.

Moisture – Good Practice

- Build the roof first for weather protection during construction
- Provide a good roof overhang to prevent driven rain saturating the render
- External walls should be set on a raised plinth with a suitable DPC

Moisture – Good Practice

- Windows and doors should be fitted towards the outer face of the wall.
- Miscellaneous penetrations through the walls should be detailed to ensure that they do not allow moisture to build up.
- Use breathable renders or plasters e.g. lime-based

Moisture - Roof

Green roof with stone and soil

- Over DPC laid loosely
- Over roofing felt laid loosely (with overlaps jointed, ends exposed and not fixed over extension)
- Over chipboard
- Over 50*50mm battens at approximately 560mm spacings

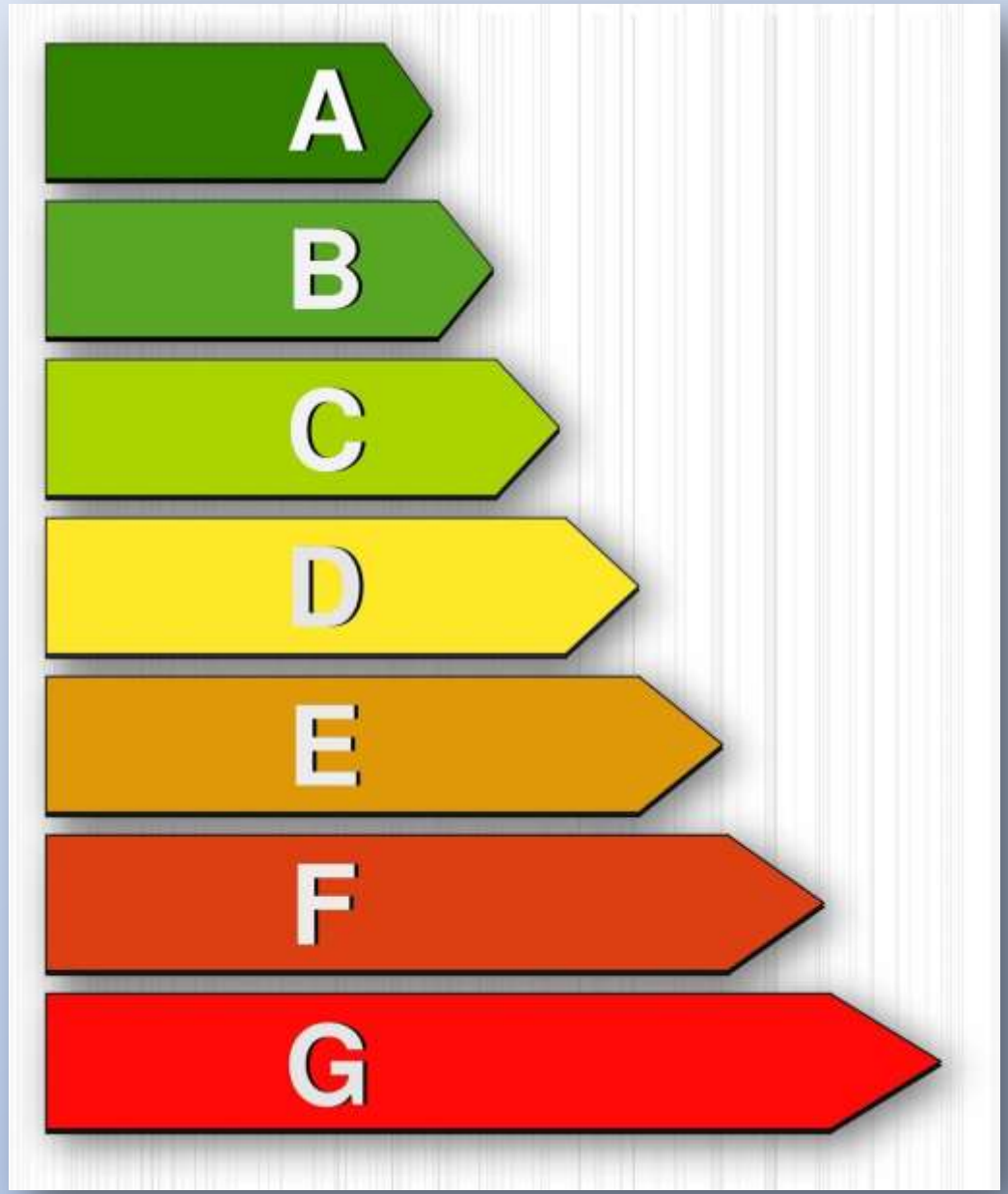
- Supported by 150*44mm rafters at maximum 1225mm spacing.

Materials and Workmanship

- Walls
  - Timber structure of untreated raw cut spruce
  - Only 1st layer of plaster leaving straw exposed (degradation)

- Durability of materials
  - Timber
  - Straw

- Roof
  - Design
  - Moisture Retention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Conservation of Heat and Energy

Numerous reports available in EU and US on U-value's of straw bale walls.

Average density about 100 kg/m3
Bale width of 450mm
Thermal conductivity of 0.06 W/mK
30mm lime render on inside and outside face,

U-Value is 0.13 W/m2K. (TGD L requires 0.21 W/m2K)

Reference Material

1. Jones Barbara. Building With Straw Bales – A practical manual for self-builders and architects.
2. Sutton, A., Black, D. and Walker, P. Information Paper IP15/11 – Straw Bale. An Introduction to low-impact building materials. BRE and University of Bath.
3. Lopez et al – Prefabricated Modular Straw Walls and Panels for houses building and building renovation
4. Timber Frame Housing Consortium – Study on timber frame housing in Ireland for the Department of Environment, heritage and Local Government
5. I.S. 440:2009+A1:2014
6. MPA Braunschiweig Classification Report Nr K-3305/558/07-2
7. Chiltern International Fire Report Chilt/RF09001
8. Intertek ETL Semko Test Report Project No. 3098054A
9. Intertek ETL Semko Test Report Project No. 3098054B
10. IRB Appendix R. Straw bale construction

Thank You