Flood resilience
Practical design considerations for new housing

Elaine Toogood
BA(HONS) Grad Dip Arch RIBA
Senior Architect, The Concrete Centre

New guidance for flood resistant and resilient construction

BS 85500: Latest British Standard (November 2015)
Practical guidance for construction of new homes, extensions and retrofit
Intended as an update to DCLG 2007 Guide: Improving the flood performance of new buildings - flood resilient construction
Terminology

Flood resilience: holistic approach i.e. resistance (keeping water out) and/or resilience (letting water in)

What do we mean by Property Level Resilience?

Property Level Resilience (PLR) aims to make people and their property less vulnerable to the physical and mental impacts of flooding.

Actions that can be taken include installing flood doors, flood barriers, air brick covers, painting or waterproofing brickwork, installing non-return valves, and moving vulnerable features such as sockets above floor level.

Properties need a package of measures, some of which prevent water entering a house and others that minimise the impact should water enter the house, speeding up the recovery process.

Sometimes the water should be let in. For floods over 10cm depth, or of prolonged duration, attempting to keep the water out can cause serious structural damage, owing to the unequal water pressures either side of the walls.

- Huge challenge to improve flood resilience of existing housing
- New development will require future retrofit measures if not considered now
- Flood resilience is not controlled through building regulation
Improved flood resilience makes people and their properties less vulnerable to the physical and mental impacts of flooding.

Improved flood resilience potentially reduces the amount of waste associated with a flood event (resource efficient).
Health and Safety of residents - responsibility of property owners/landlords

Likelihood of flood events are increasing

Change in residential properties at risk of flooding (more frequent than 1:75 years) assuming the CLA Adaptation Scenario (no population growth)

Source: Climate Change Risk Assessment 2017 projections of future flood risk in the UK October 2015: Sayers and partners LLP
‘Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.’

Specific flood risk assessments are required for large developments and those at identified flood risk, incorporating climate change forecasts from the EA [www.Planningguidance.communities.gov.uk](http://www.Planningguidance.communities.gov.uk)

There always remains a residual risk of flooding, even where there are flood prevention measures in place

“It is therefore important that these buildings are designed to be resistant or resilient to flooding”.
New developments under 1 hectare requires no site specific flood risk assessment if in Flood Zone 1

Flood risk may be greater than it appears

York: River flooding
York: River AND surface water flooding

Flood Analysis from Jeremy Benn Associates
Predicted flood risks change

- Flood performance requirements are based on flood risk predictions
- Predictions are based on data
- Data varies e.g. granularity, type of flood risk, current climate change predictions
- Conditions on the ground change

Recent flooding in Crayford caused by burst water main
Flood risk assessment

Establish:

- Depth
- Duration
- Type of flood

To determine best design strategy to take and predicted flood level to consider

Design strategies for flood resilience in order of preference

- **Avoidance**: Raise ground or floor levels above flood level
- **Site layout**: Bunds, boundary walls & landscaping to delay flood water
- **Mitigation**: Reduce impact of flood on the building itself
  - **Resistance** (water exclusion - ‘dry-proof’)
    Construction of a building in such a way as to prevent or minimise flood water entering the building and damaging its fabric
  - **Resilience** (water entry- ‘wet proof’)
    Measures in the building fabric and/or fixtures and fittings to reduce the consequences of flood water entering the property
Mitigation strategies (BS 85500)

<table>
<thead>
<tr>
<th>Design flood water depth above ground floor level</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 300mm</td>
<td>Resistance *</td>
</tr>
<tr>
<td>300mm to 600mm</td>
<td>Resistance + resilience</td>
</tr>
<tr>
<td>More than 600mm</td>
<td>Resilience + resistance for lesser events</td>
</tr>
</tbody>
</table>

*+ resilience for ground water and long duration flooding
- Resistance measures also recommended also for sea water and flooded sewer systems and to provide time for evacuation

- Design detailing dependant upon anticipated flood type (e.g. duration, depth)
- A combination of resistance and resilience should be provided for most flooding situations
Living spaces, enclosed with masonry, raised above flood levels on cast in situ concrete plinth

Living spaces raised above flood level by concrete structure

Walls above constructed using ICF system
Site layout

SuDs (Sustainable Urban Drainage Systems) to reduce surface water flood risk (part of avoidance strategy)

Wide selection of permeable paving systems and integrated drainage products available using concrete

Site layout

Green roofs

- Reducing surface water run off and risk of flash flooding
Site layout

Bunds or perimeter defences can delay floods but are not appropriate for ground water risk and potentially increase flood risk elsewhere

LifeE > Non-defensive flood risk management

Long-term Initiatives for Flood-risk Environments

- **Safe Havens**
  - Resident Schools and community buildings provide safe spots to gather and centres for renewable energy

- **Rain Gardens**
  - Communal gardens collect and store rainwater away from rivers

- **Green Roofs**
  - Green roofs can slow down the flow of rainwater, easing flooding

- **Flood Gardens/Safe Houses**
  - Flood water can pass through the garden without affecting the house

- **Canal Paths**
  - Planted pathways are designed to channel flood water away from homes

- **Village Blue**
  - Small ponds are designed to expand during a flood. The rest of the time they can be used for boating, fishing and swimming

- **Village Green**
  - Play areas are designed to flood when a really big flood occurs

Baca Architects > www.baca.uk.com > mail@baca.uk.com
Flood avoidance: Floating

Living with water

Floating houses in the Netherlands

Amphibious House

FLOOD MITIGATION COULD LOOK LIKE THIS
Preferred option for floor and wall construction

Solid wall construction (with external render/closed cell insulation)

Based on Figure 5, BS85500:2015

Wimbish Passiv Haus
Parsons + Whittley
Solid wall construction
(with external render/ closed cell insulation)

- Strength and stability to resist water penetration
- Durable external finishes/low or easy maintenance
- Structural integrity in flood or damp conditions
- No voids or cavities to clear
- Less drying time needed with high density concrete solutions
- Excellent thermal performance
- Low thermal bridging
- High thermal mass
- Very low airtightness

• Precast concrete with external insulation achieving Passivhaus standard
ICF construction
(with external render)

- Strength and stability to resist water penetration
- Durable external finishes/low or easy maintenance
- Structural integrity in flood or damp conditions
- No voids or cavities to clear

Brookwood Farm, Woking
Code 5 homes

- Insulated permanent formwork system for cast in situ concrete (ICF)
- Excellent thermal performance
- Low thermal bridging
- Very low airtightness
Cavity wall construction options

Alternative recommended wall constructions in BS 85500 for resistance and resilience flood strategies

All cavities have block work inner leaf

Masonry cavity wall construction

- Common, cost effective form of construction
- High thermal performance possible

Chester Balmore Passivhaus
Rick Mather architects
Precast concrete insulated sandwich panel

- Meets principles of BS 85500

Restricted option for floor construction

Based on Figure 6, BS85500:2015

Suspended slab, precast or in situ
Access to void required
Suspended concrete floor
(ground-supported, continuous DPM, closed cell insulation)

- Not included as a solution for flood resilience in BS 85500 (it wasn’t tested)
- Durability, strength and stability in damp conditions
- Standard practice could be adapted to improve flood resilience

(Timber floor no longer a restricted option, as it was in 2007)

Guidance for flood resistant and resilient construction

Updates 2007 guidance to include research into reaction of modern materials and construction methods to flooding

New section on hazards of potential flood impacts on different building elements

All recommended and preferred wall and floor constructions illustrated for resistance and resilience are concrete or masonry

More detailing guidance on connections/details required
Other detailing considerations

- Good quality construction/workmanship
- Consideration of junction between elements, well sealed, buildability
- Attention to detail: fully filling beds and cross mortar joints/tooled finish/stainless steel wall ties
- Insulation: closed cell and well fixed. Location needs consideration
- Internal wall linings: resilient, breathable plaster (lime based rather than gypsum) to reduce risk of deterioration - or provide sacrificial linings beyond flood level
- Internal floor finishes: resilient, washable finishes e.g. screed/tiles - or sacrificial floor finishes
- Pumps/sumps/internal drainage
- The right type of screed

Further guidance

Download www.concretecentre.com/publications
Note: Produced 2009 so contains superseded policy refs (eg PPS25) but still some useful practical guidance
New guidance in progress
• Whole house approach required
  (including services locations/ door details, internal finishes & layouts and walls/ concrete lower steps to stairs)
• Get structure and waterproofing right to facilitate future flood resilient enhancements
THANK YOU

etoogood@concretecentre.com

@elainetoogood

https://floodsdestroy.campaign.gov.uk/