Simplifying design and construction

Alan Tovey, Director
The Basement Information Centre
Simplifying design and construction

- Grades of construction
- Construction options
- Design and waterproofing issues
- Basement Approved Document – 2004
- Other Available information
Available Information - Publications

- Basement 3 - Thermal insulation (1993)
- Basement 4 – Layout Design Example (1994)
- Waterproofing existing structures (BSWA, 2005)
- Basement Land use (2) (1998)
- Others on Website www.basements.org.uk
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Pending
- Approved Document additions - Plain Masonry and Plain In-situ Conc. Retaining Walls due for Public Comment Feb 2005
Grades and types of construction
Table 1 (BS 8102) Guide to level of protection to suit basement use

<table>
<thead>
<tr>
<th>Grade</th>
<th>Basement usage</th>
<th>Performance level</th>
<th>Form of construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Car parking: plant rooms (excluding electrical equipment); workshops</td>
<td>Some seepage and damp patches tolerable</td>
<td>Type B - BS8110</td>
</tr>
<tr>
<td>2</td>
<td>Workshops and plant rooms requiring drier environment; retail storage areas</td>
<td>No water penetration but moisture vapour tolerable</td>
<td>Type A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Type B - BS 8007</td>
</tr>
<tr>
<td>3</td>
<td>Ventilated residential and working areas including offices, restaurants etc.,</td>
<td>Dry environment</td>
<td>Type A</td>
</tr>
<tr>
<td></td>
<td>leisure centres</td>
<td></td>
<td>Type B - BS 8007</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Type C</td>
</tr>
<tr>
<td>4</td>
<td>Archives and stores requiring controlled environment</td>
<td>Totally dry environment</td>
<td>Type A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Type B - BS 800</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Type C ventilated (+ vapour control)</td>
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2 Minimum for garages

3 Minimum for accommodation

Approved Document - Basements for dwellings
Wall construction types - BS8102

WALL TYPE A
(Masonry)

WALL TYPE B
(Insitu concrete)

WALL TYPE C
(Concrete – new build)
(Masonry – existing)

- **Total reliance on waterproofing**
- **Structure provides main water resistance**
- **Structure provides some water resistance with internal drainage system**
TYPE A STRUCTURES
( Tanked protection )

External waterproofing

Sandwich waterproofing

Internal waterproofing
**TYPE B STRUCTURES**
(Structurally integral protection)

- Kickered construction
  - External or internal waterstop as reqd

- Kickerless construction
  - Crystallization, hydrophilic or injected waterstop
TYPE C STRUCTURES
( Drained protection )

Preformed cavity floor and wall drain system

Drainage sump with pumped outlet
Part C – Resistance to moisture
AD – Basement for dwellings 2004

- Generally water-proofing recommendations same:
  as in 1997 version except Type C now with full sump
### Fig 2A.4 Acceptability of construction types

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<td>BS 8110</td>
</tr>
<tr>
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<td>✓</td>
<td>✓</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
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<td>✓</td>
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**Notes**

1. In high water table seek manufacturer’s advise
2. Some constructions may be suitable depending on conditions

From: Approved Document – Basements for Dwellings
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Decreasing risk

Notes:
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<td>CONSTRUCTION</td>
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Notes:
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2. Some constructions may be suitable depending on conditions

From: Approved Document – Basements for Dwellings
Construction options
TYPICAL RANGE OF CONSTRUCTION METHODS

- Reinforcement
  - Restraining ties
- Expanded polystyrene formwork system
- In-situ concrete infill
- EPS formwork

- Reinforcement
  - In-situ concrete
- Wall ties
- Masonry

- Reinforcement
  - Precast concrete
Types of construction

Masonry Basement Walls
Filled hollow blocks

Plan view

Key items
- Strength of units
- Reinforcement - Vert and Horiz
- Compaction ??
- Waterproofing details

Cross section

Water proofing

Running bond may offset cores

Cores not parallel
Filled cavity block wall

Plan view

Cross section

Key items
- Strength of units.
- Reinforcement - Vert and Horiz.
- Compaction – easier
  (100mm continuous cavity)
- Waterproofing details

Water proofing
Types of construction - contd

Pre-cast and PC insulated

Pre-cast/insitu hybrid walls

Expanded Polystyrene Formwork

Poured In-Situ Basement Wall
Pre-cast/insitu hybrid walls
Expanded Polystyrene Formwork
Expanded Polystyrene Formwork
Poured In-Situ Basement Wall
Design and Water proofing issues
Design Considerations

- Structure
- Waterproofing
- Repair
WATERPROOFING DESIGN PRINCIPLES

- Decide on basement usage
- Gather site information
- Decide on form of construction
- Decide on form of waterproofing
Fig 2A.1
Determining appropriate form of basement construction and waterproofing
Determining appropriate form of basement construction and waterproofing

Is Construction buildable?

Yes

SOLUTION

No

Proposed development

Site survey

Design considerations

Basement Construction Type A/B/C

Selection of Waterproofing system

- Basement use
- Environmental requirements
- Geology
- Water table
- Topography
- Soil drainage
- House type and Foundation design
External drainage

- Geocomposite drainage sheet
- Percolating ground water
- Perimeter drain (fin or land drain to discharge water to down side)
- Basement structure
- External or internal waterproofing as appropriate

Ground level

If external drained used to control conditions >> Make rodable
External or internal waterproofing as appropriate

Basement structure

- Generally waterproofing to basement to be continuous
- Adequate details must be provided for junction, etc
- Details and construction should be as simple as possible
Continuity seems simple

But essential to consider with structure

External or internal waterproofing as appropriate?
Waterproofing Details
Assumed continuity!!??
Foundation details
Type A structure - strip foundation

External or internal waterproofing

Discontinuity between slab and wall

External or internal waterproofing

Slab built-in
Foundation details
Type A structure - piled foundation

Internal waterproofing

Difficult to achieve external waterproofing
Interaction of water proofing with structure
Structural design - Waterproofing

Simple design of section

Ultimately won’t fail but serviceability conditions may affect waterproofing
Design structure in three dimensions

Cross section

Bending moments in structure
Design structure in three dimensions

Cross section

Bending moments in structure

Plan

Corner moments sometimes overlooked
Continuity of horizontal reinforcement in masonry walls (Figure 3A.3, AD Basements)

Horizontal reinforcement = 0.5 $A_s$ along wall and around corners

Plan view

Main vertical reinforcement

Cross section

Similar detail provided for insitu walls (Fig 3B.2)
Insitu concrete options

Comment - Need to consider construction abilities/difficulties
Design in three dimensions - waterproofing

Drawing is simple in two dimensions
But structures are three dimensional!!
Design in three dimensions - waterproofing

Drawing is simple in two dimensions
But structures are three dimensional!!

Waterproofing membrane shown following thickened profile

Cross section

Membrane likely to require preformed sections to cater for mitre

Plan view at corner

Comment: If not catered for can lead to construction defects
Design in three dimensions - waterproofing

Drawing is simple in two dimensions
But structures are three dimensional!!

Waterproofing membrane

Cross section

Simpler square corner no mitre

Comment: Design can help waterproofing

Plan view at corner
Ensure compatibility between waterproofing and structure

Stress and crack width controlled by reinforcement. Likely to be compatible with most waterproofing membranes.

In an unreinforced wall, crack width is uncontrolled. May exceed strain capacity of some waterproofing membranes.

Comment: Structural behaviour can affect selection of waterproofing
Can basement be investigated and repaired?

Example 1

May influence re-design and choice of waterproofing. Internal/External?

Structure designed for water-resistance (Type B)
Can basement be investigated and repaired?

Example 1

May influence re-design and choice of waterproofing. Internal/External?

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May influence re-design and choice of waterproofing. Internal/External?

Structure designed for water-resistance (Type B)
Can basement be investigated and repaired?

Example 1
Structure designed for water-resistance (Type B)

Example 2
Basement under part of area of house

May influence re-design and choice of waterproofing. Internal/External?
Other Design Issues
The new Approved Document – Basements for dwellings

Amended to deal with B Regs 2000

Covers A, B, C, E, F, H, K, L, N, J
and Vehicle access
As for AD 1991 +
Plus Part M
Contents Contd

- Stairs, ramps and guards (K)
- Glazing - materials and protection (N)
- Drainage and waste disposal (H)
- Heat producing appliances (J)
- Vehicle access
Significant guidance on:

- Site preparation and resistance to moisture
- Structure
- Conservation of fuel and power
‘Site preparation and resistance to moisture’

Gives Guidance on:

- Subsoil drainage
- Obtaining water-resistance
‘Structure’

Gives Guidance on:

- Masonry retaining walls
- In-situ concrete retaining walls
- Foundations - plain and reinforced
**Masonry retaining walls**

**Table 3A.2 AD - Basements: Minimum masonry strength and reinforcement for 2.7 m propped retaining wall**

<table>
<thead>
<tr>
<th>Foundation type</th>
<th>Soil type (well drained)</th>
<th>Vertical load (kN/m) up to</th>
<th>Moment taken at base of wall (kN/m)</th>
<th>Block comp. strength (N/mm²)</th>
<th>Brick comp. strength (N/mm²)</th>
<th>Area of reinforcement As (mm²/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip</td>
<td>Clay</td>
<td>70</td>
<td>17</td>
<td>7</td>
<td>20</td>
<td>530</td>
</tr>
<tr>
<td></td>
<td>Granular</td>
<td>12</td>
<td>7</td>
<td>7</td>
<td>20</td>
<td>340</td>
</tr>
</tbody>
</table>

- Table in AD also covers raft foundation and different vertical load
- Similar tables for 2.1 m and 1.6 m cantilevered walls
## Insitu concrete retaining walls

### Table 3B.1 Minimum reinforcement for 2.7 m propped in-situ concrete retaining wall

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- Table in AD also covers raft foundation and different vertical load
- Similar tables for 2.1 m and 1.6 m cantilevered walls
Foundation requirements for strip foundation

- Retained ground
- Basement
- Width of foundation: (a) + (b)
- Cover 40 mm
- Reinforcement as paragraph 3B.3.4
- Centre line of retaining wall

Requirement for raft foundation

- Retained ground
- Foundation should extend past centreline of retaining wall by a distance equal to 2T, where T is the thickness of the foundation
- Cover 40 mm
- Reinforcement as paragraph 3C.5.2
- Centre line of retaining wall
- Cover 20 mm
- Internal wall
- Reinforcement as paragraph 3C.5.3
- Reinforcement as paragraph 3C.5.1
- 1200 mm minimum
‘Conservation of fuel and power’

Gives Guidance on:

- General requirements
- Tables for wall insulation thickness
- Tables for floor insulation thickness
- Calculation procedures

Only in AD – Basements for dwellings Not included in AD L1
Simplifying design and construction

- Available information, Inc AD Basements
- Grades of construction, Construction options
- Design and waterproofing issues
  - Structure
  - Waterproofing
  - Repair
  - Adopt simple details
- Approved Document – 2004
  Simplifies design for walls, and foundations and aids reliability
And so to the finished project

By simplifying the design
Building into the Basement