



# 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

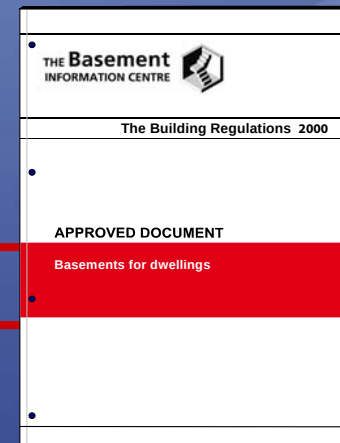
- ❖ Basement 1 - Benefits and costs (1991, 1999, 2005)
- ❖ Basement 2 - Design Guide – Soil pressures and masonry (1991)
- ❖ Basement 3 - Thermal insulation (1993)
- ❖ Basement 4 – Layout Design Example (1994)
- ❖ Waterproofing Design Guide (1994)
- ❖ Waterproofing Site Guide (1994)
- ❖ Waterproofing existing structures (BSWA, 2005)
- ❖ Approved Document – (1997, 2004)
- ❖ Basement Land use (2) (1998)
- ❖ Others on Website [www.basements.org.uk](http://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

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

# Table 1 (BS 8102) Guide to level of protection to suit basement use

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

# Table 1 (BS 8102) Guide to level of protection to suit basement use

| Grade    | Basement usage                                                                                | Performance level                                  | Form of construction                                               |
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| <b>1</b> | Car parking; plant rooms (excluding electrical equipment); workshops                          | Some seepage and damp patches tolerable            | Type B - BS8110                                                    |
| <b>2</b> | Workshops and plant rooms requiring drier environment; retail storage areas                   | No water penetration but moisture vapour tolerable | Type A<br>Type B - BS 8007                                         |
| <b>3</b> | Ventilated residential and working areas including offices, restaurants etc., leisure centres | Dry environment                                    | Type A<br>Type B - BS 8007<br>Type C                               |
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Table 1 (BS 8102) Guide to level of protection to suit basement use

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2 Minimum for garages

3 Minimum for accommodation

Approved Document -  
Basements for dwellings

# Wall construction types - BS8102

Total reliance  
on  
waterproofing



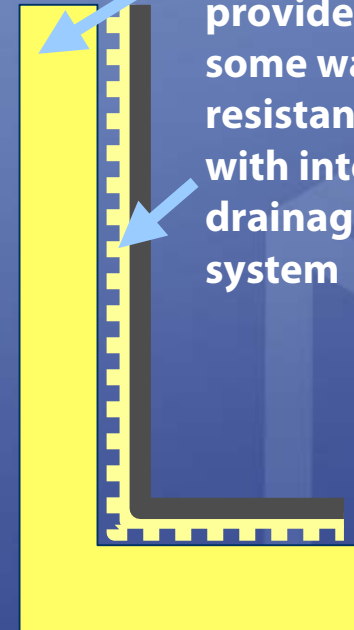
WALL TYPE A  
(Masonry)

Structure  
provides  
main water  
resistance



WALL TYPE B  
(Insitu concrete)

Structure  
provides  
some water  
resistance  
with internal  
drainage  
system

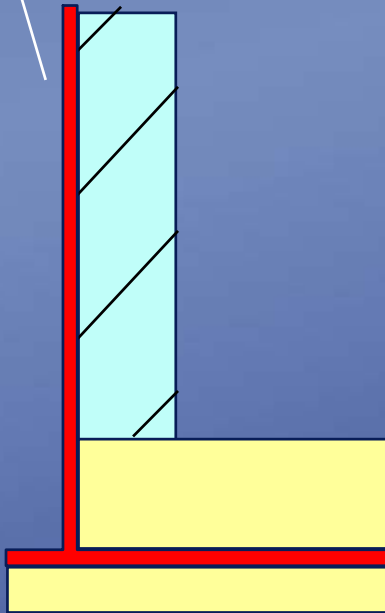


WALL TYPE C  
(concrete – new build)  
(masonry – existing)

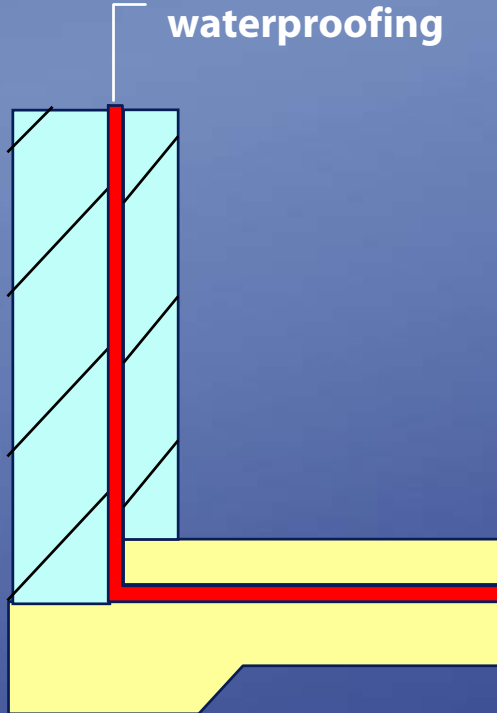
# TYPE A STRUCTURES

( Tanked protection )

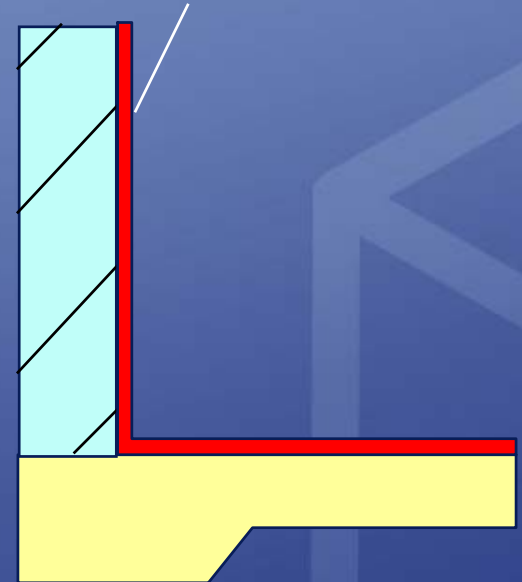
External  
waterproofing



Sandwich  
waterproofing

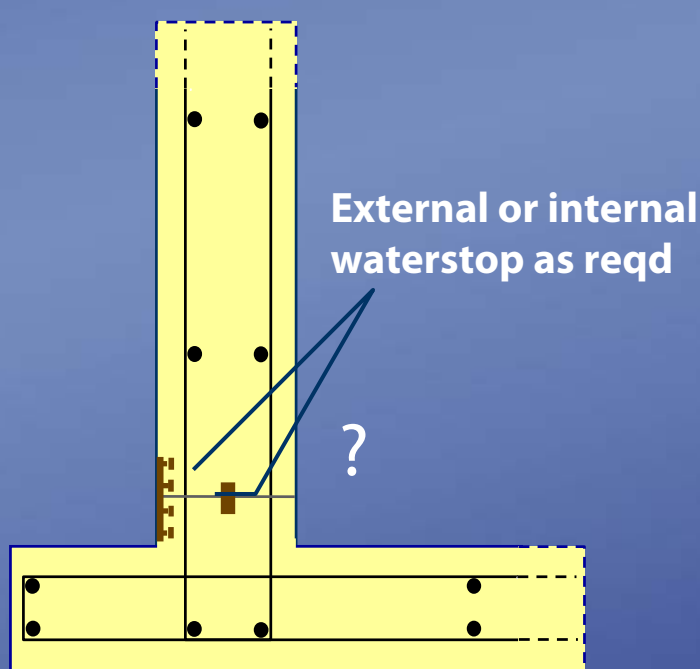


Internal  
waterproofing

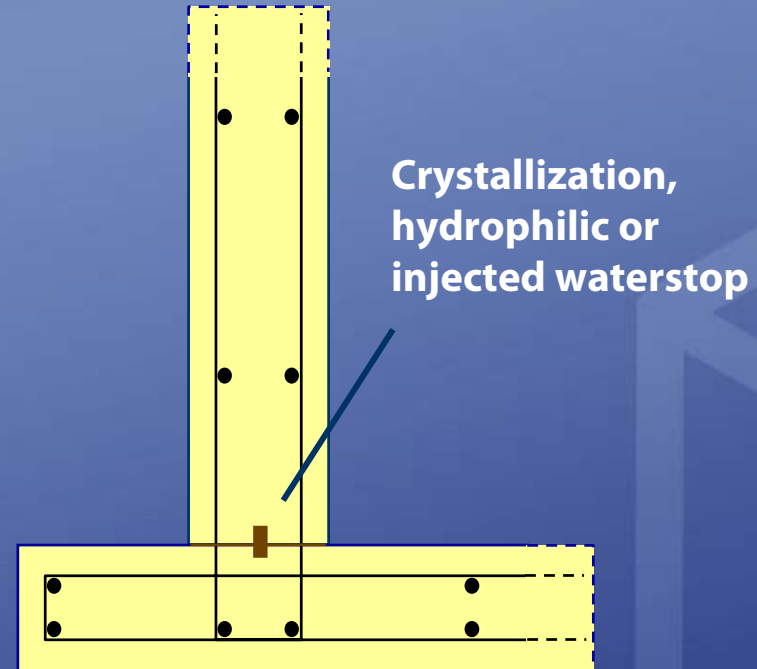


# TYPE B STRUCTURES

( Structurally integral protection )



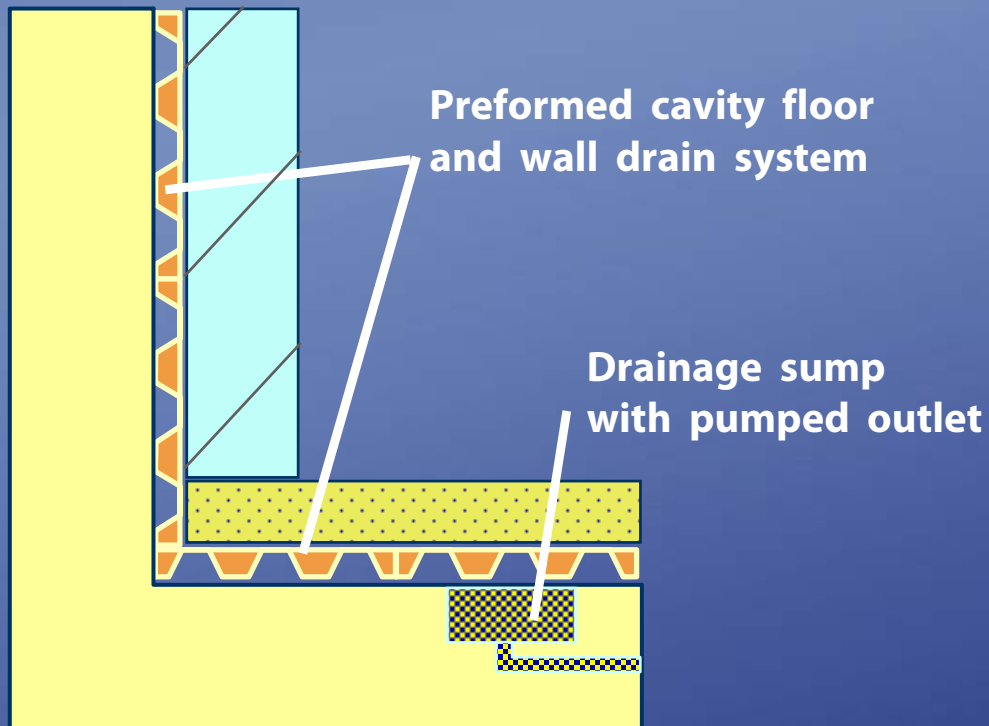
Kickered construction



Kickerless construction

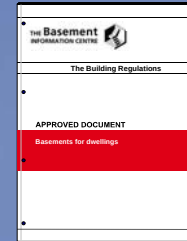
# TYPE C STRUCTURES

( Drained protection )

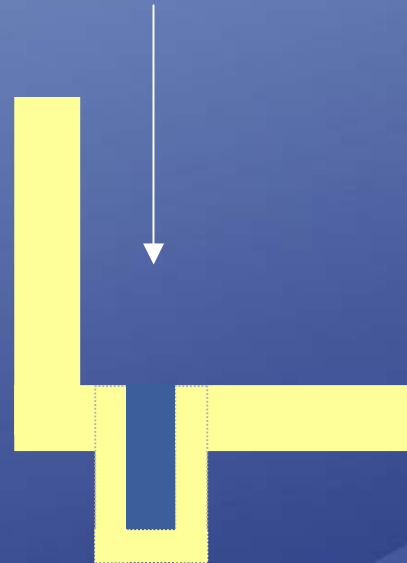


# Part C – Resistance to moisture

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

| Water table                                      | Type A                                                                                                             |               | Type B  |                 |              |                 | Type C                |         |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------|---------|-----------------|--------------|-----------------|-----------------------|---------|
|                                                  | Water-proofing                                                                                                     | Plus drainage | BS 8110 | Plus W-proofing | BS 8007      | Plus W-proofing | BS 8110               | BS 8007 |
|                                                  |                                                                                                                    |               |         |                 |              |                 | Plus moisture barrier |         |
| Low                                              | ✓                                                                                                                  | ✓             | ✓       | ✓               | ✓            | ✓               | ✓                     | ✓       |
| Variable                                         | See Note 2                                                                                                         |               |         | ✓               | ACCEPTABLE   |                 | ✓                     | ✓       |
|                                                  |                                                                                                                    |               |         |                 | ✓            | ✓               |                       |         |
| High                                             | Not recommended                                                                                                    |               |         | ✓<br>Note 1     | CONSTRUCTION |                 | ✓                     | ✓       |
|                                                  |                                                                                                                    |               |         |                 | ✓            | ✓<br>Note 1     |                       |         |
| <div><div></div>Decreasing risk<div></div></div> |                                                                                                                    |               |         |                 |              |                 |                       |         |
| Notes                                            | 1. In high water table seek manufacturer's advise<br>2. Some constructions may be suitable depending on conditions |               |         |                 |              |                 |                       |         |

From : Approved Document – Basements for Dwellings

# Fig 2A.4 Acceptability of construction types

| Water table                             | Type A                                                                                                             |               | Type B  |                 |              |                 | Type C                |         |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------|---------|-----------------|--------------|-----------------|-----------------------|---------|
|                                         | Water-proofing                                                                                                     | Plus drainage | BS 8110 | Plus W-proofing | BS 8007      | Plus W-proofing | BS 8110               | BS 8007 |
|                                         |                                                                                                                    |               |         |                 |              |                 | Plus moisture barrier |         |
| Low                                     | ✓                                                                                                                  | ✓             | ✓       | ✓               | ✓            | ✓               | ✓                     | ✓       |
| Variable                                | See Note 2                                                                                                         |               |         | ✓               | ACCEPTABLE   |                 | ✓                     | ✓       |
|                                         |                                                                                                                    |               |         |                 | ✓            | ✓               |                       |         |
| High                                    | Not recommended                                                                                                    |               |         | ✓<br>Note 1     | CONSTRUCTION |                 | ✓                     | ✓       |
|                                         |                                                                                                                    |               |         |                 | ✓            | ✓<br>Note 1     |                       |         |
| <div>————— Decreasing risk —————▶</div> |                                                                                                                    |               |         |                 |              |                 |                       |         |
| Notes                                   | 1. In high water table seek manufacturer's advise<br>2. Some constructions may be suitable depending on conditions |               |         |                 |              |                 |                       |         |

From : Approved Document – Basements for Dwellings

# Fig 2A.4 Acceptability of construction types

| Water table                                                 | Type A                                                                                                             |               | Type B  |                 |              |                 | Type C                |         |
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|                                                             | Water-proofing                                                                                                     | Plus drainage | BS 8110 | Plus W-proofing | BS 8007      | Plus W-proofing | BS 8110               | BS 8007 |
|                                                             |                                                                                                                    |               |         |                 |              |                 | Plus moisture barrier |         |
| Low                                                         | ✓                                                                                                                  | ✓             | ✓       | ✓               | ✓            | ✓               | ✓                     | ✓       |
| Variable                                                    | See Note 2                                                                                                         |               |         | ✓               | ACCEPTABLE   |                 | ✓                     | ✓       |
|                                                             |                                                                                                                    |               |         |                 | ✓            | ✓               |                       |         |
| High                                                        | Not recommended                                                                                                    |               |         | ✓<br>Note 1     | CONSTRUCTION |                 | ✓                     | ✓       |
|                                                             |                                                                                                                    |               |         |                 | ✓            | ✓<br>Note 1     |                       |         |
| <div><div></div><div>Decreasing risk</div><div></div></div> |                                                                                                                    |               |         |                 |              |                 |                       |         |
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|                                         |                                                                                                                    |               |         |                 |              |                 | Plus moisture barrier |         |
| Low                                     | ✓                                                                                                                  | ✓             | ✓       | ✓               | ✓            | ✓               | ✓                     | ✓       |
| Variable                                | See Note 2                                                                                                         |               |         | ✓               | ACCEPTABLE   |                 | ✓                     | ✓       |
|                                         |                                                                                                                    |               |         |                 | ✓            | ✓               |                       |         |
| High                                    | Not recommended                                                                                                    |               |         | ✓<br>Note 1     | CONSTRUCTION |                 | ✓                     | ✓       |
|                                         |                                                                                                                    |               |         |                 | ✓            | ✓<br>Note 1     |                       |         |
| <div>————— Decreasing risk —————▶</div> |                                                                                                                    |               |         |                 |              |                 |                       |         |
| Notes                                   | 1. In high water table seek manufacturer's advise<br>2. Some constructions may be suitable depending on conditions |               |         |                 |              |                 |                       |         |

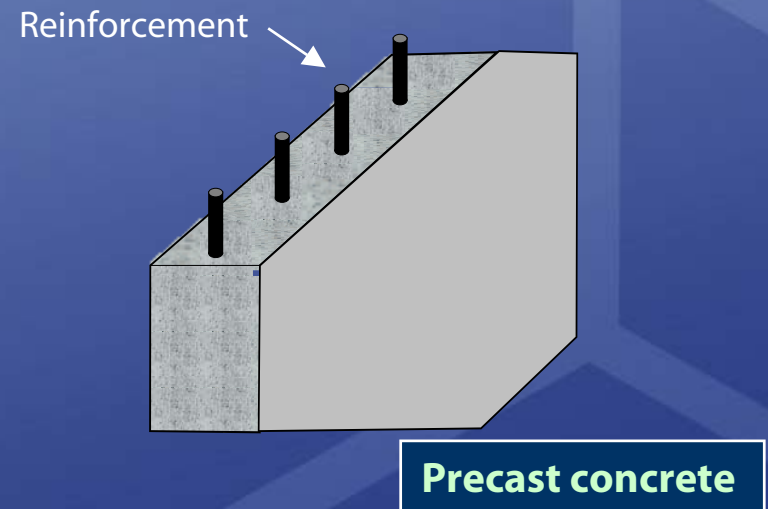
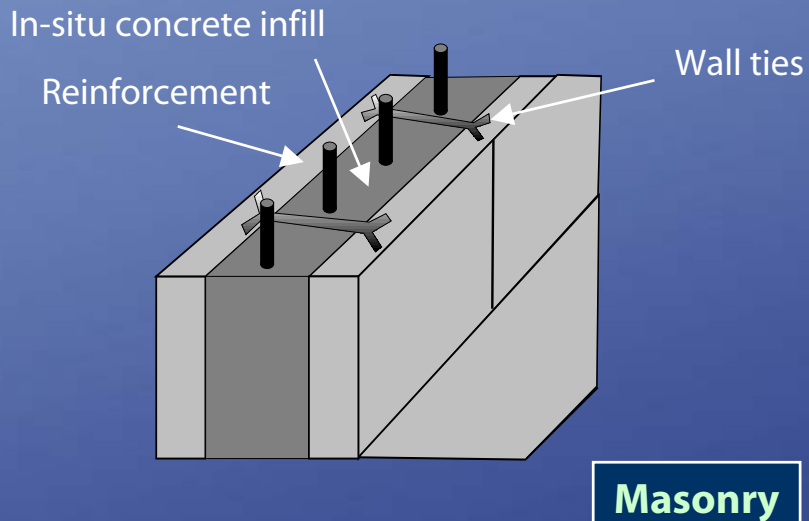
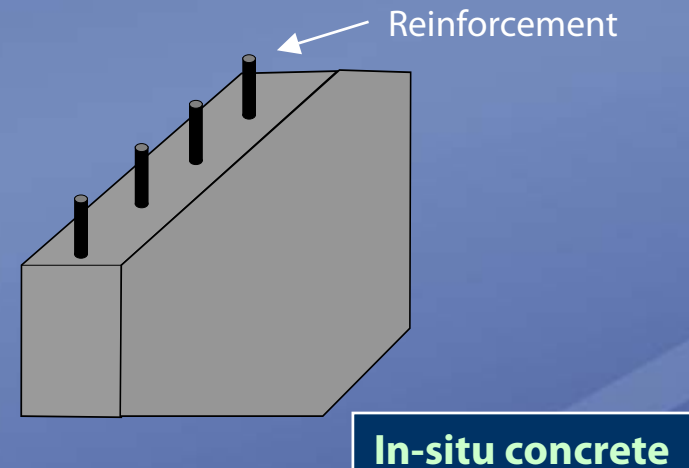
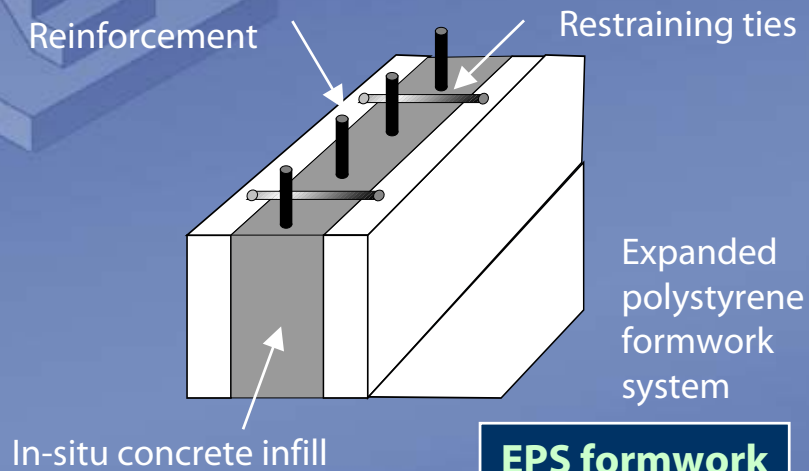
From : Approved Document – Basements for Dwellings



# **Construction options**



# TYPICAL RANGE OF CONSTRUCTION METHODS



# Types of construction

## Masonry Basement Walls



# Filled hollow blocks

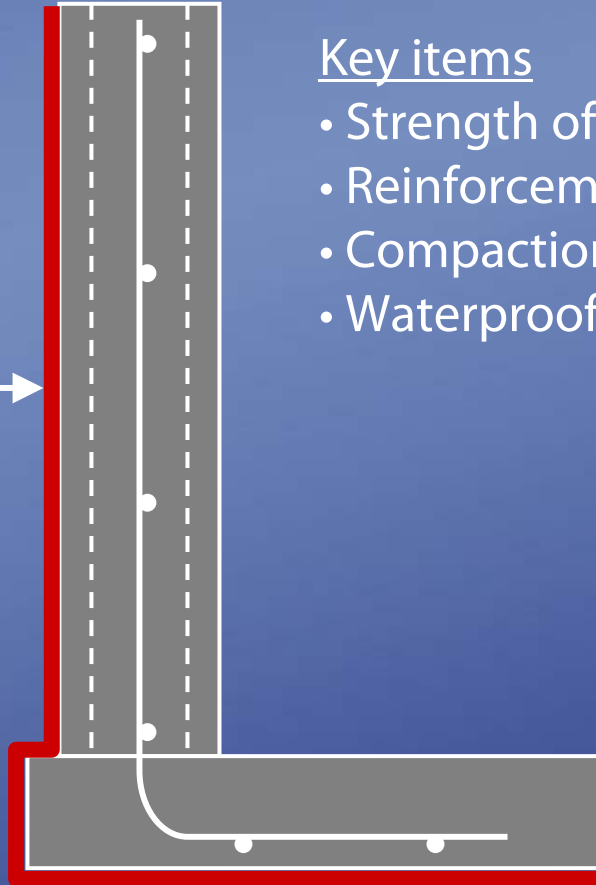
## Plan view



### Key items

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

Water  
proofing



## Cross section

Running bond  
may offset cores

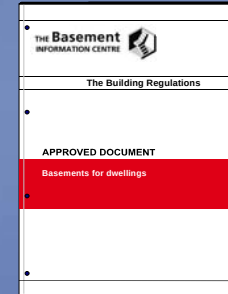
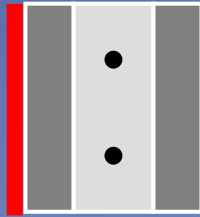


Cores not  
parallel



# Filled cavity block wall

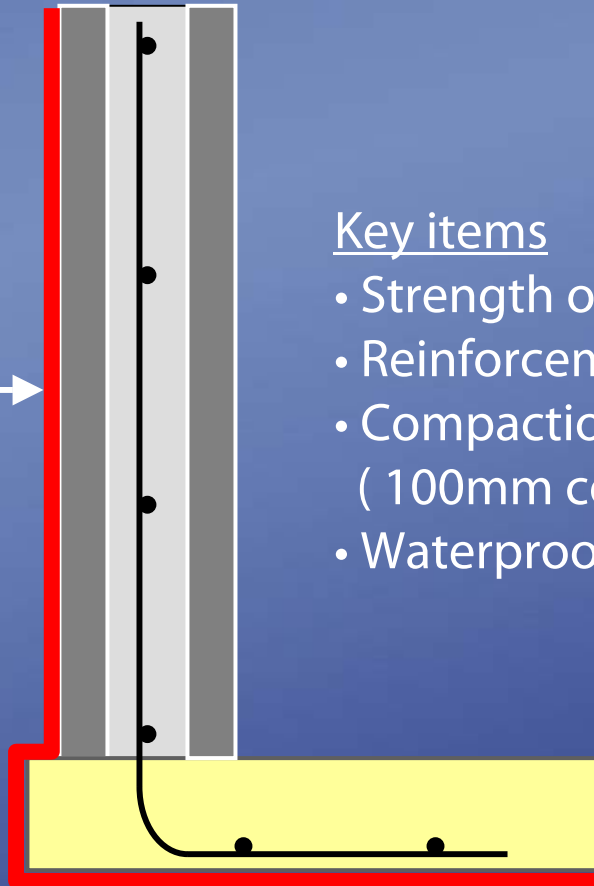
## Plan view



## Key items

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

Water proofing



## Cross section

# Types of construction - contd

Pre-cast and PC insulated



Pre-cast/insitu hybrid walls



Expanded Polystyrene Formwork



Poured In-Situ Basement Wall



# Pre-Cast Concrete 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



The text is centered and flanked by two dark blue curved arrows pointing in opposite directions, forming a circular loop around the text.



# **WATERPROOFING DESIGN PRINCIPLES**

- **Decide on basement usage**
  - **Gather site information**
  - **Decide on form of construction**
  - **Decide on form of waterproofing**
- 

# Approved Document

Fig 2A.1

Determining appropriate form of basement construction and waterproofing

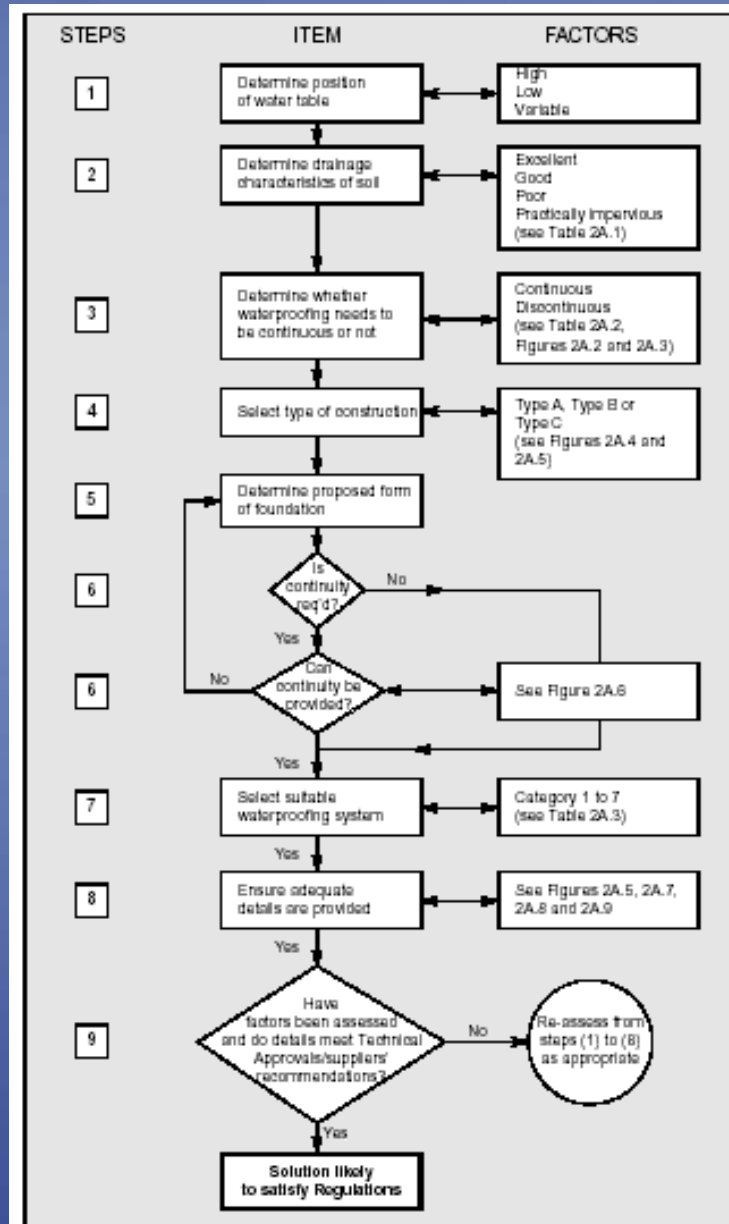
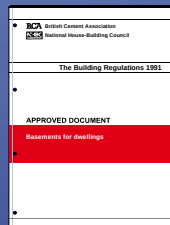
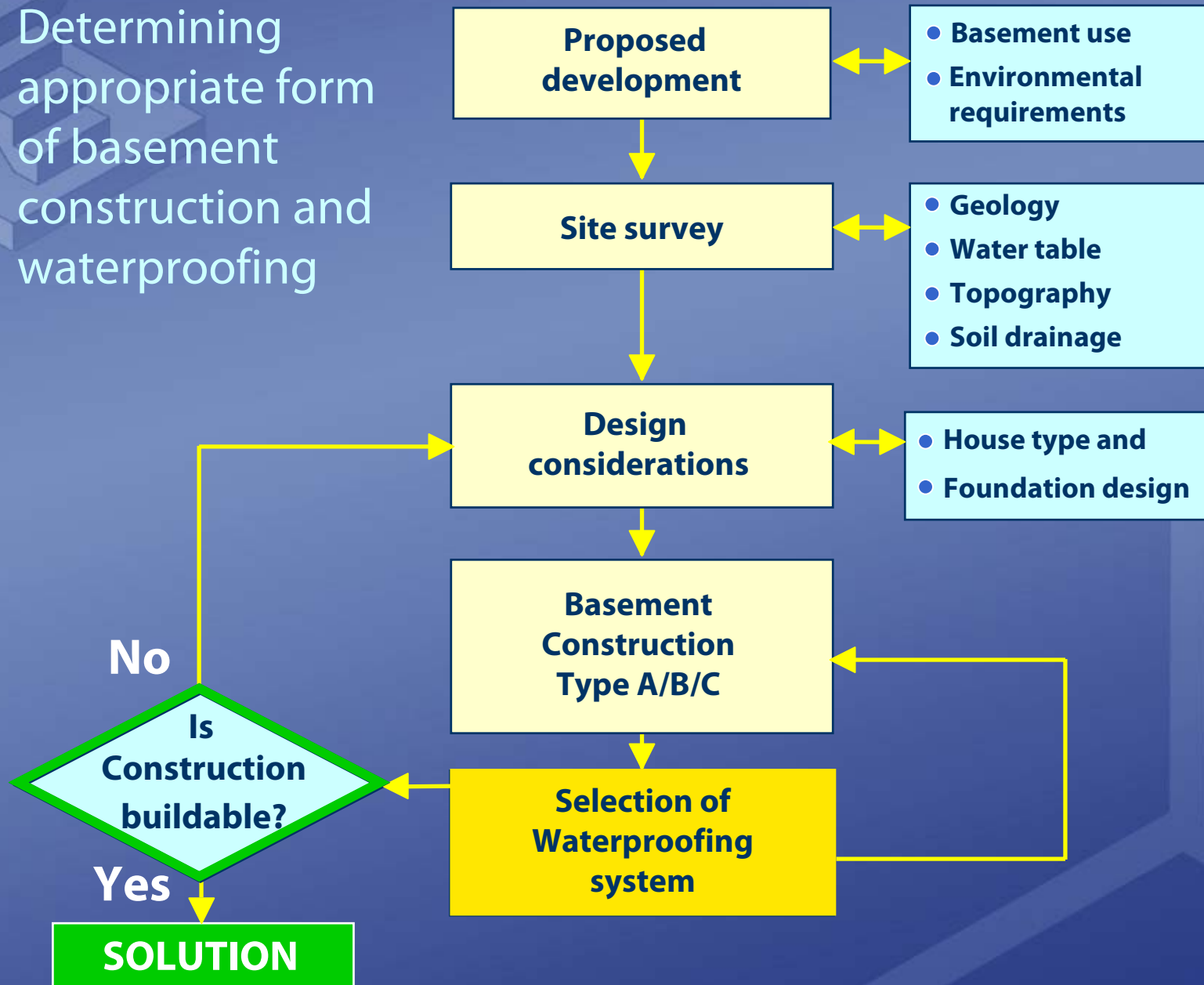


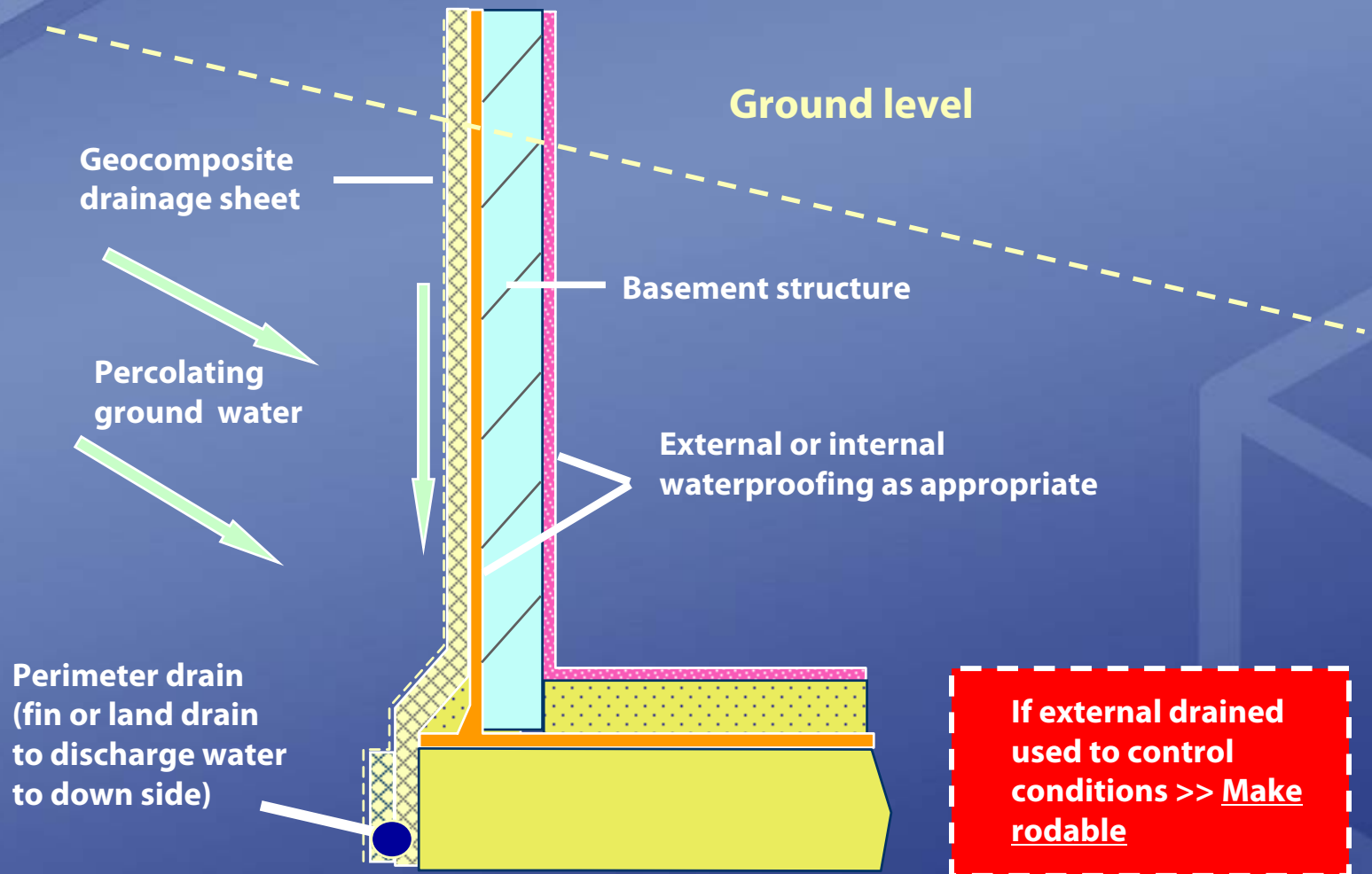
Figure 2A.1 Determining appropriate form of basement construction and waterproofing

9 Stages

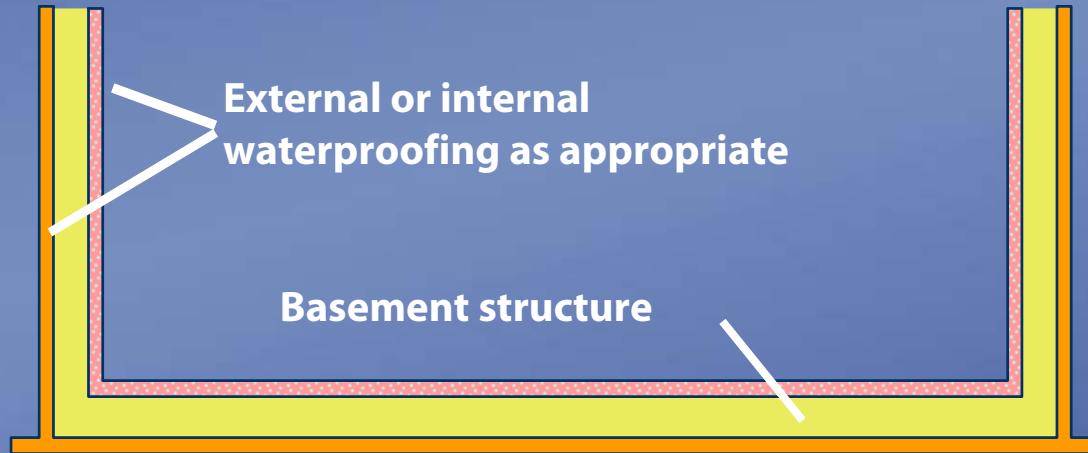
Determining appropriate form of basement construction and waterproofing



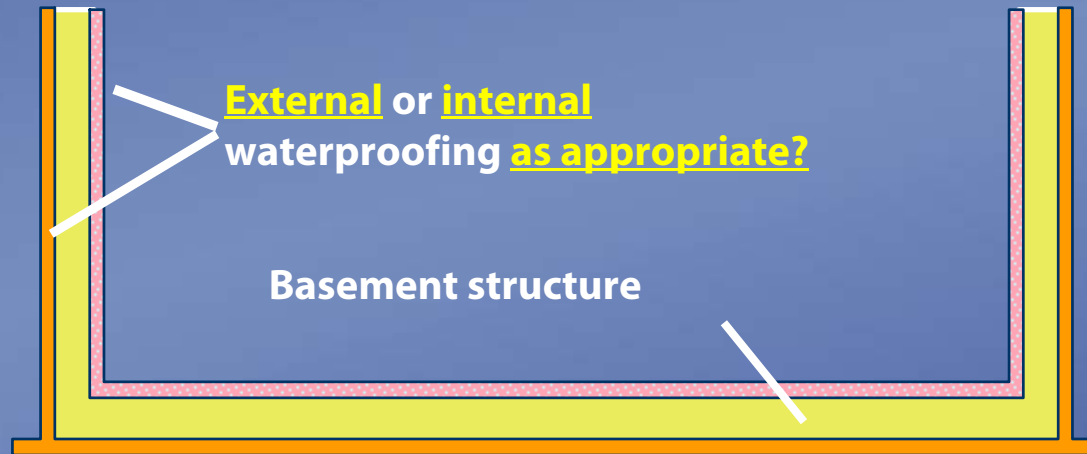
# External drainage



# General principles



- ❖ 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

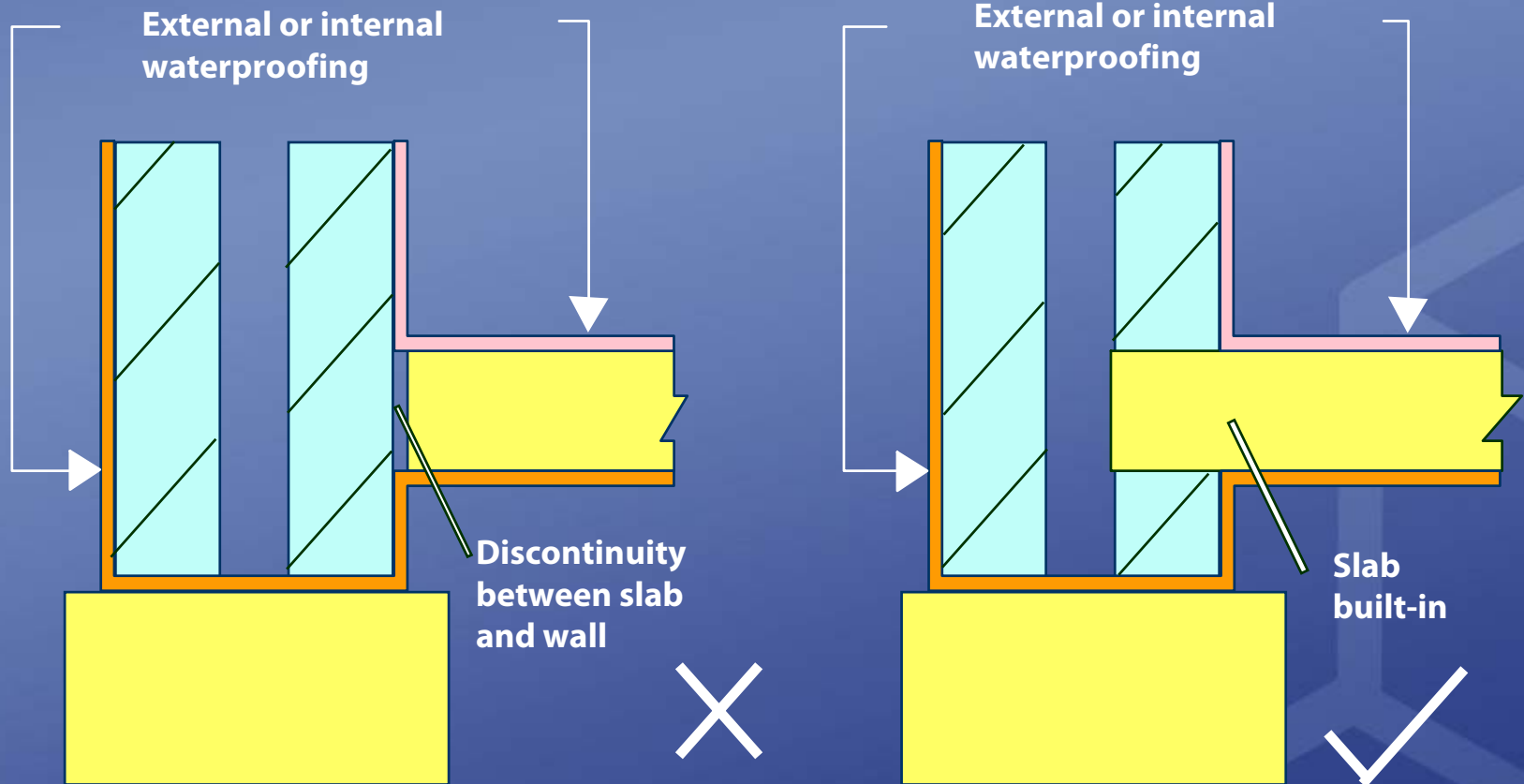


# **Waterproofing Details**

## **Assumed continuity!!??**

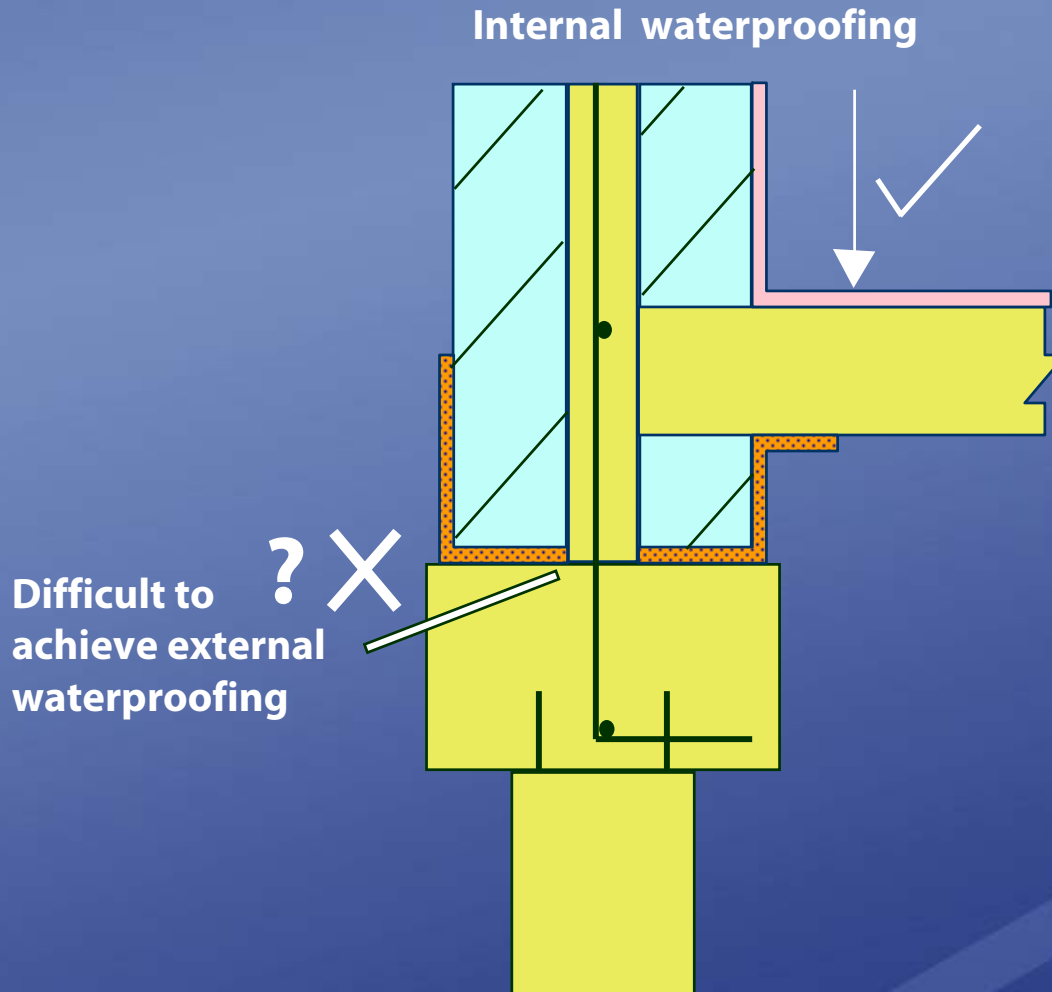
# Foundation details

## Type A structure - strip foundation



# Foundation details

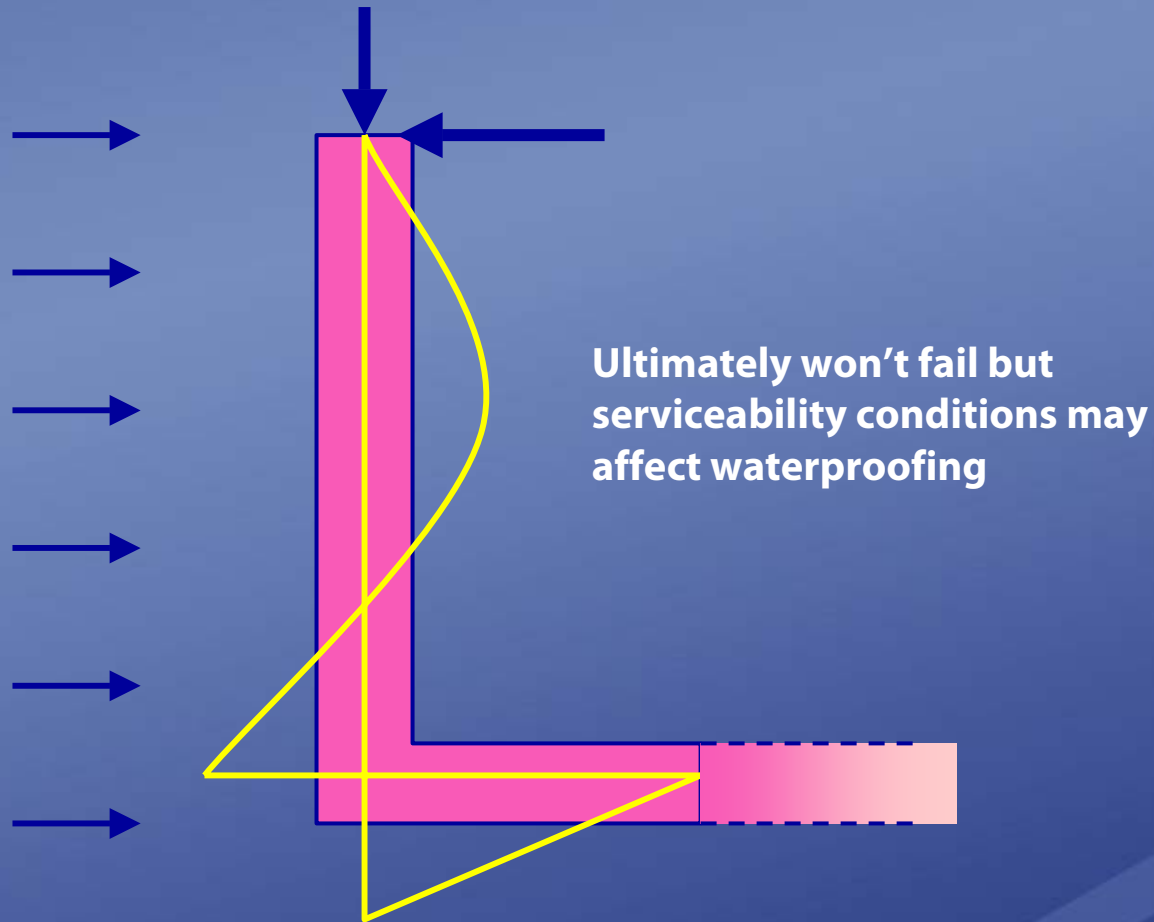
Type A structure - piled foundation





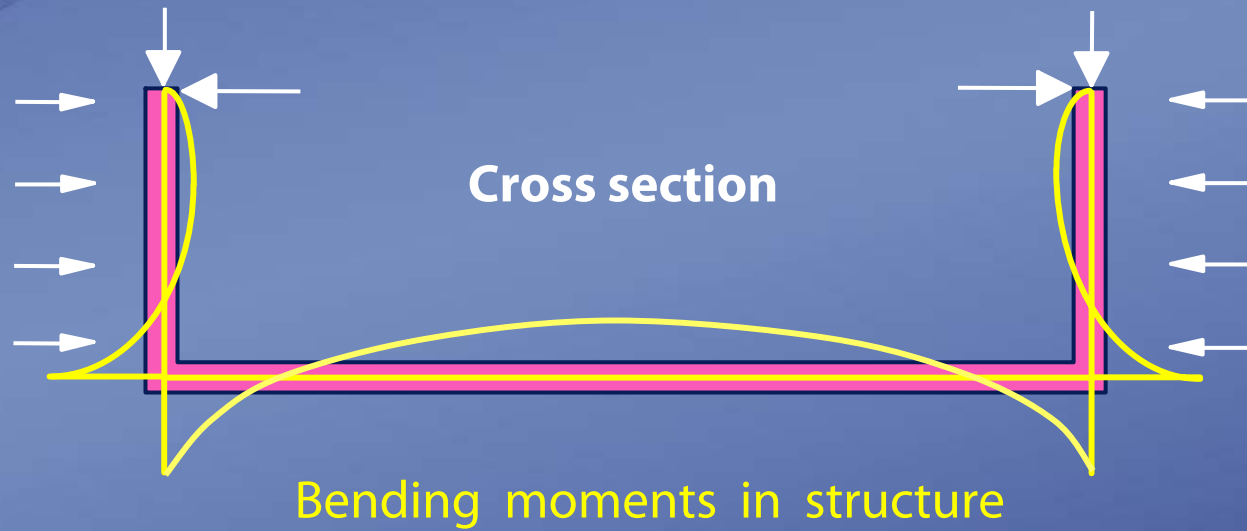
# **Interaction of water proofing with structure**

# Structural design - Waterproofing

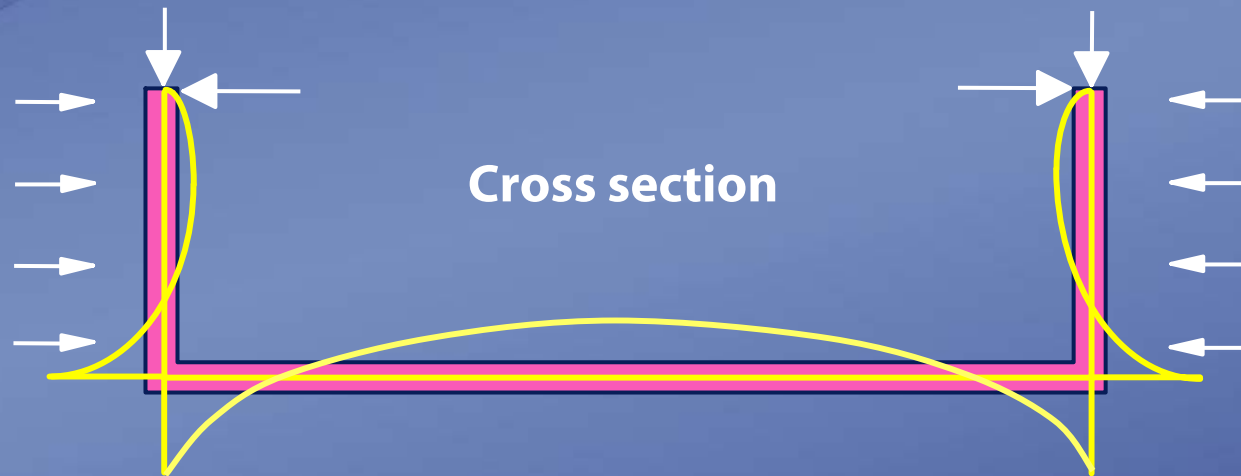


Simple design of section

# Design structure in three dimensions

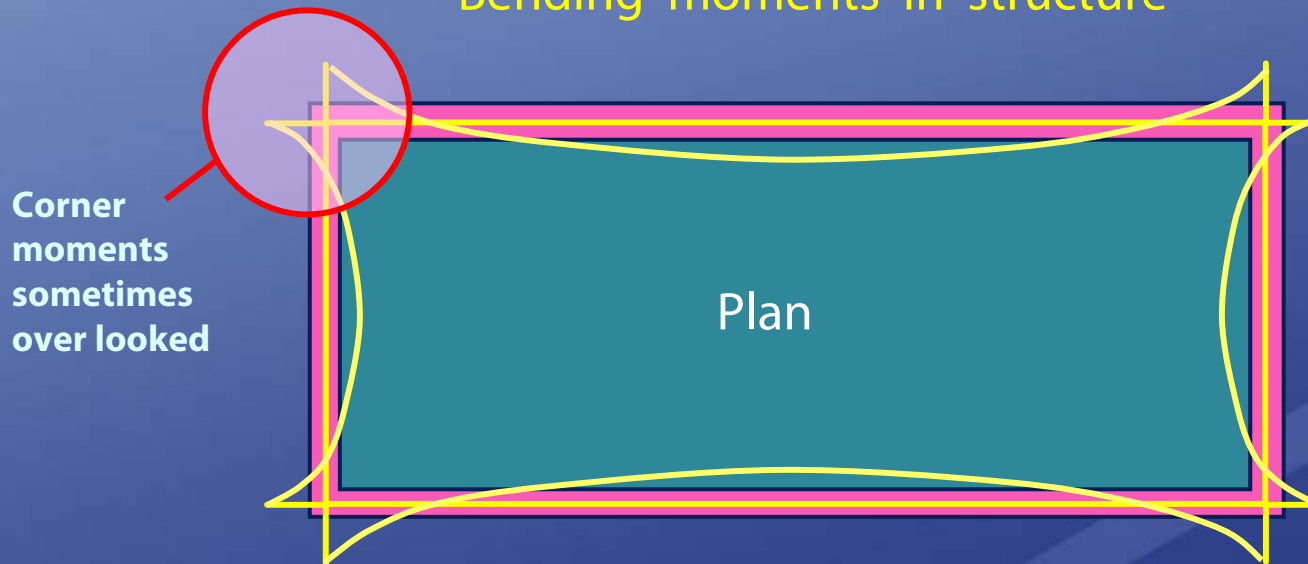


# Design structure in three dimensions



Cross section

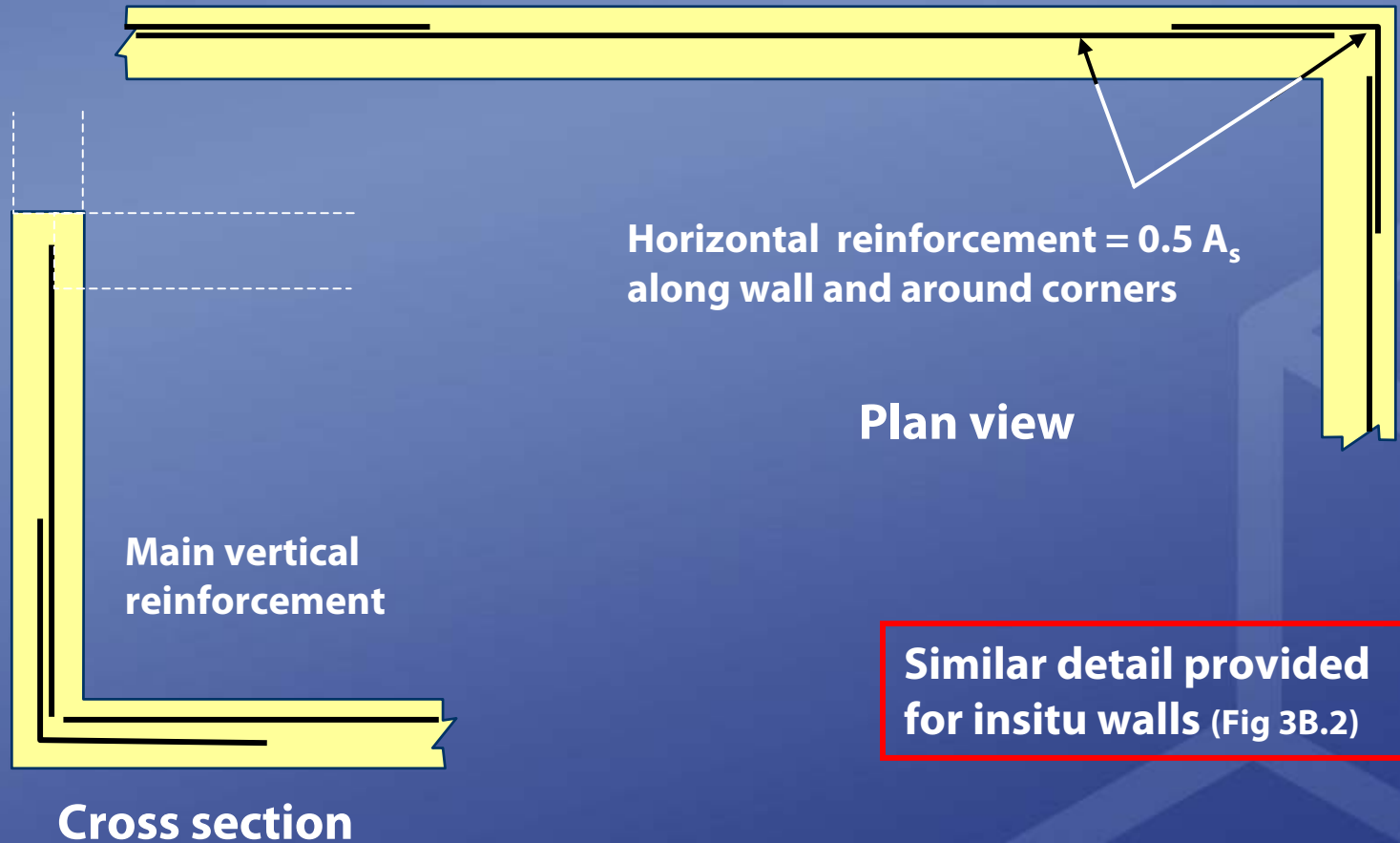
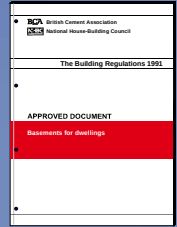
Bending moments in structure



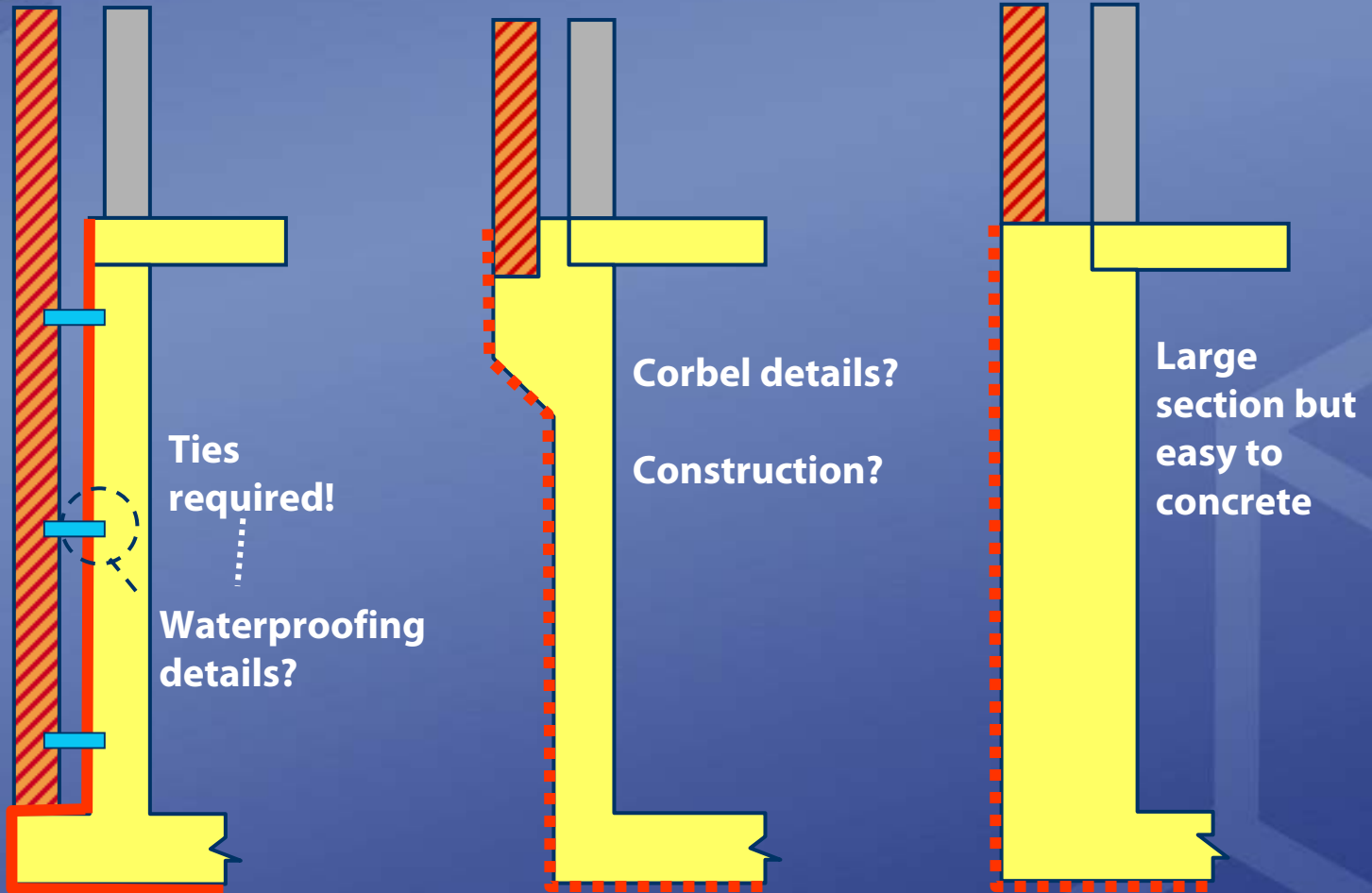
Corner moments  
sometimes  
over looked

Plan

# Continuity of horizontal reinforcement in masonry walls (Figure 3A.3, AD Basements)



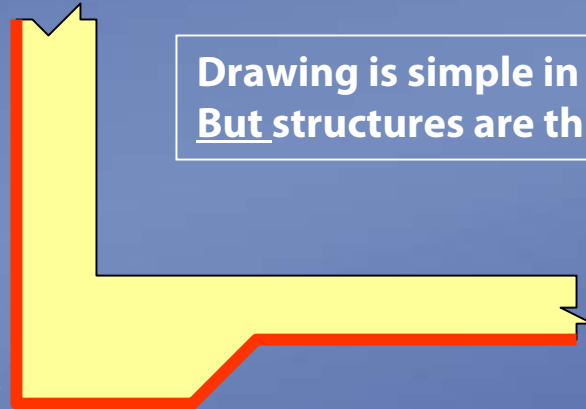
# Insitu concrete options



Comment - Need to consider construction abilities/difficulties

# Design in three dimensions - waterproofing

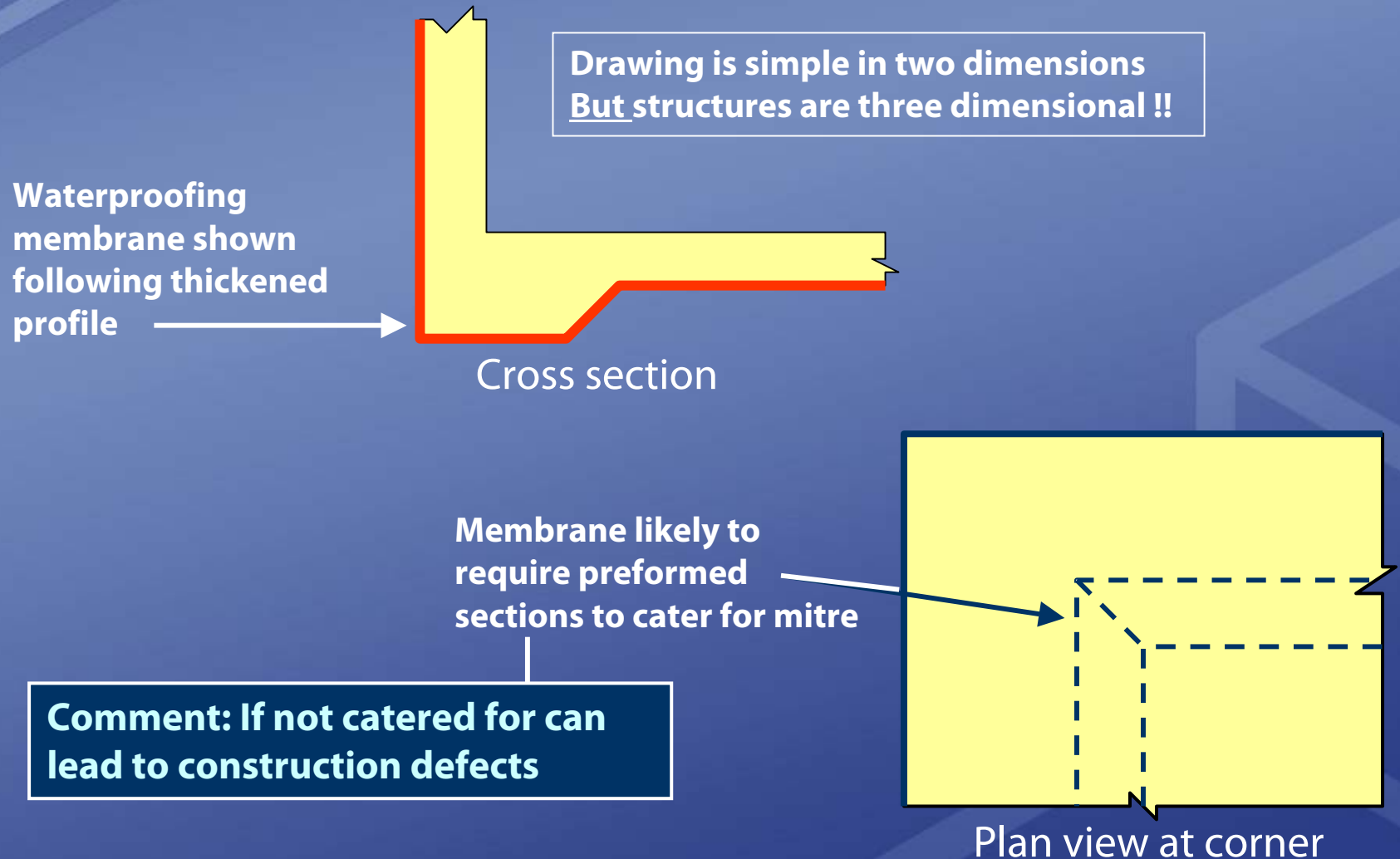
Waterproofing  
membrane shown  
following thickened  
profile



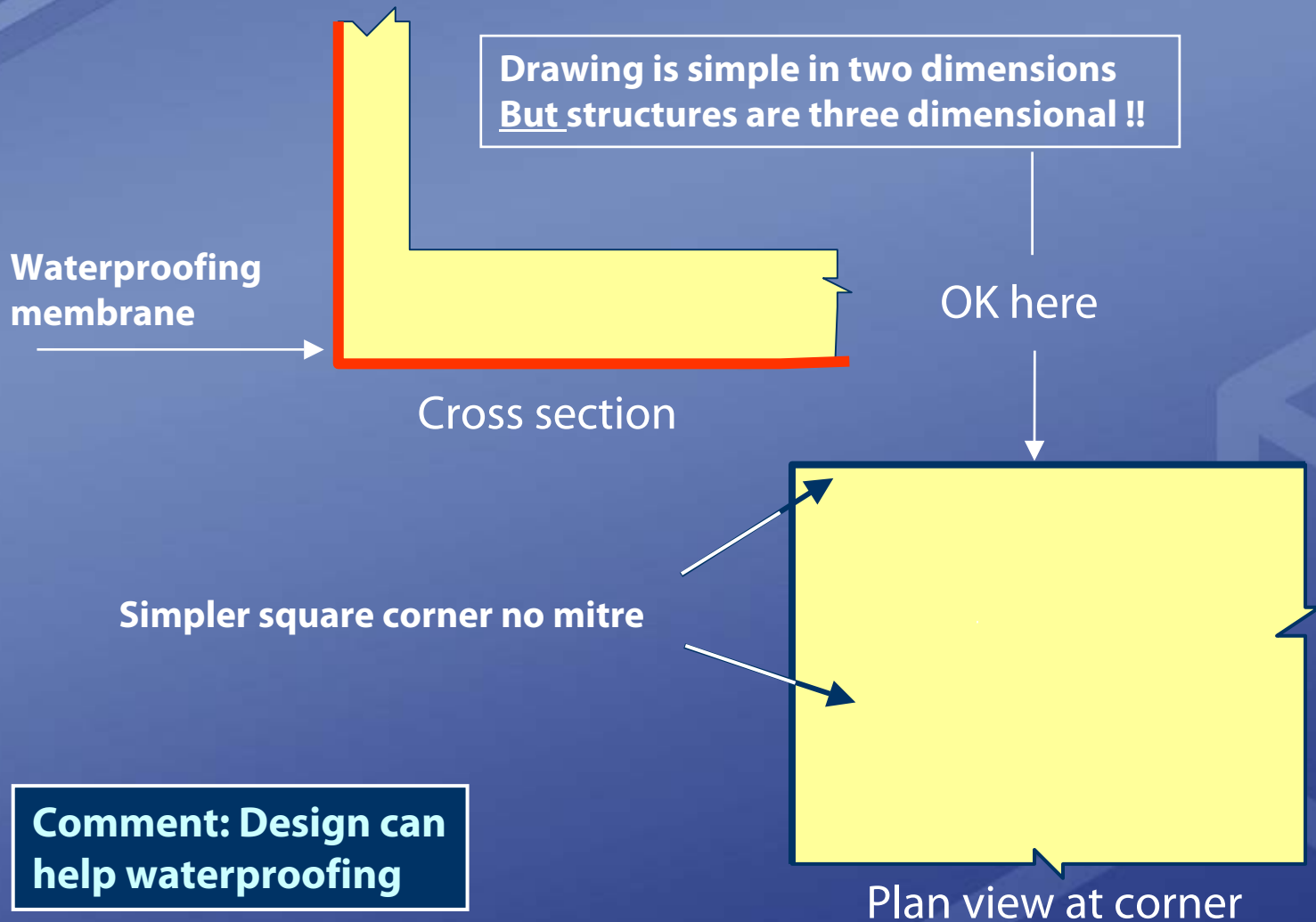
Cross section

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

# Design in three dimensions - waterproofing



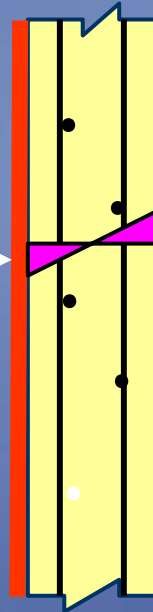
# Design in three dimensions - waterproofing



# Ensure compatibility between waterproofing and structure

Stress and crack width controlled by reinforcement.

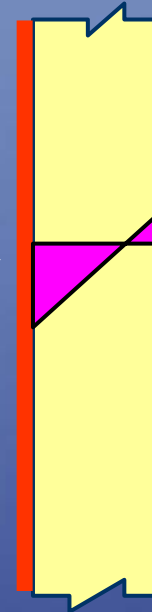
----->  
Likely to be compatible with most waterproofing membranes.



Reinforced wall

In an unreinforced wall, crack width is uncontrolled.

----->  
May exceed strain capacity of some waterproofing membranes.



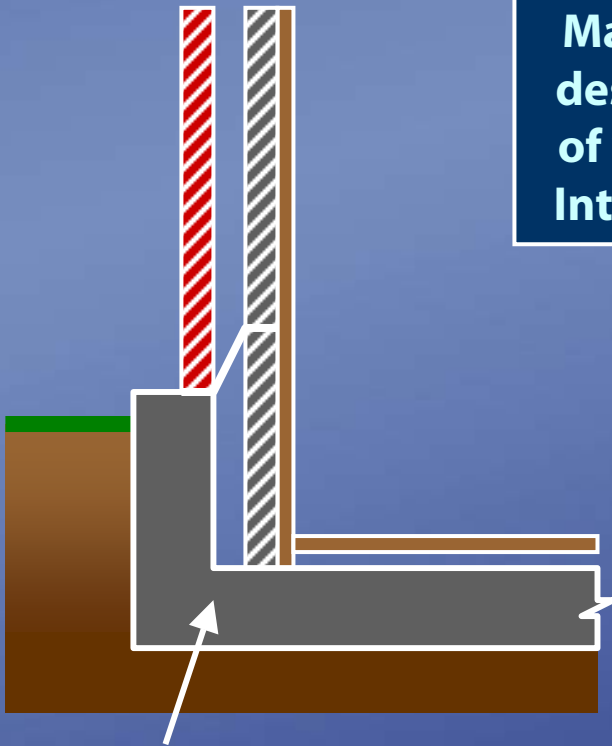
Un-reinforced wall

**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?**

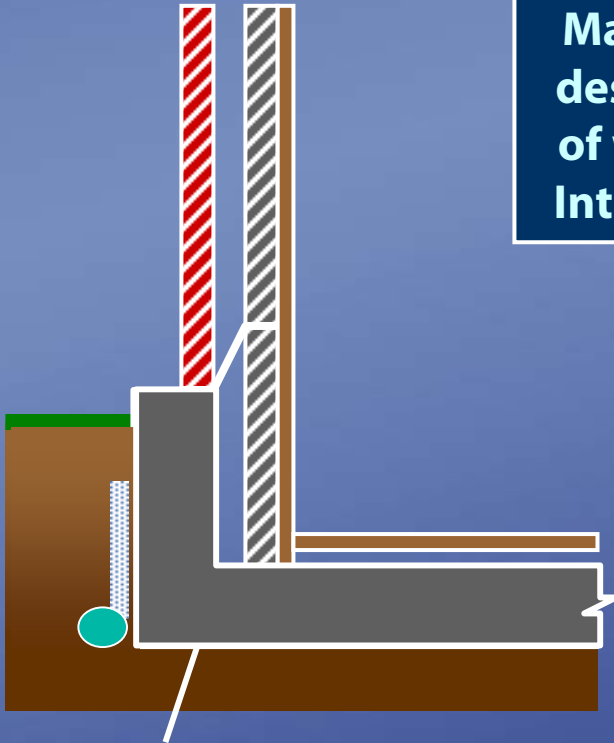


**Structure designed for  
water-resistance (Type B)**

# Can basement be investigated and repaired?

Example 1

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

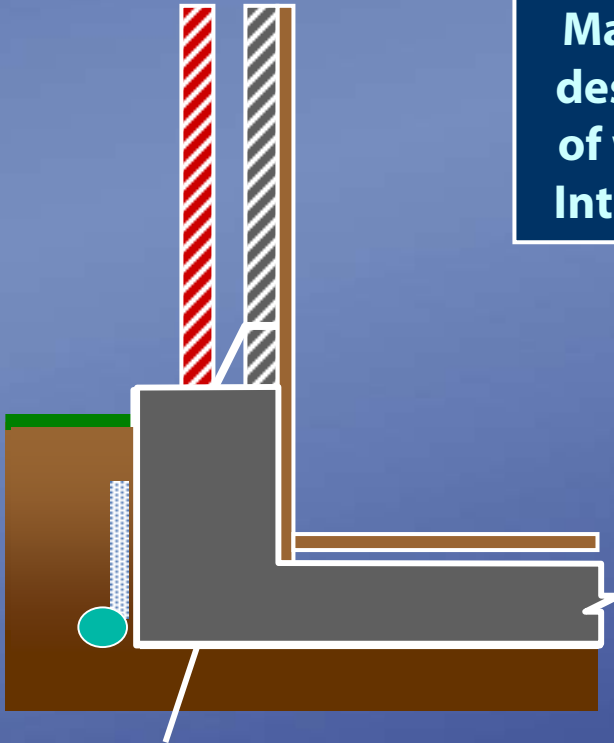


Structure designed for  
water-resistance (Type B)

# Can basement be investigated and repaired?

Example 1

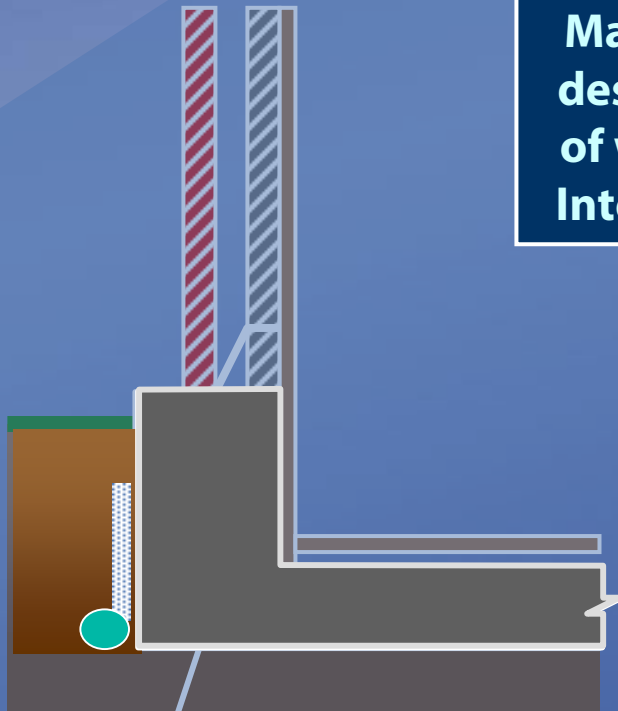
**May influence re-  
design and choice  
of waterproofing.  
Internal/External?**



**Structure designed for  
water-resistance (Type B)**

# Can basement be investigated and repaired?

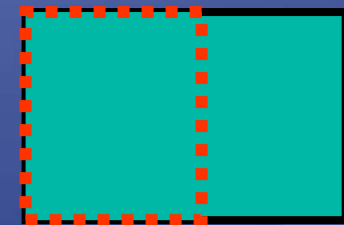
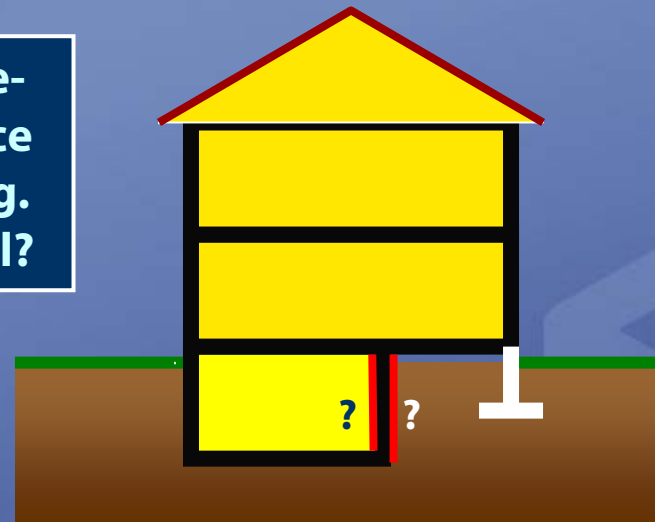
Example 1



Structure designed for  
water-resistance (Type B)

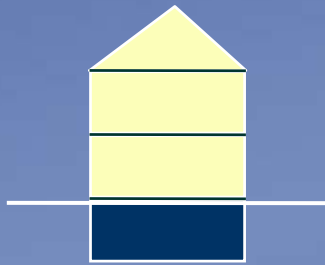
May influence re-  
design and choice  
of waterproofing.  
Internal/External?

Example 2



Plan

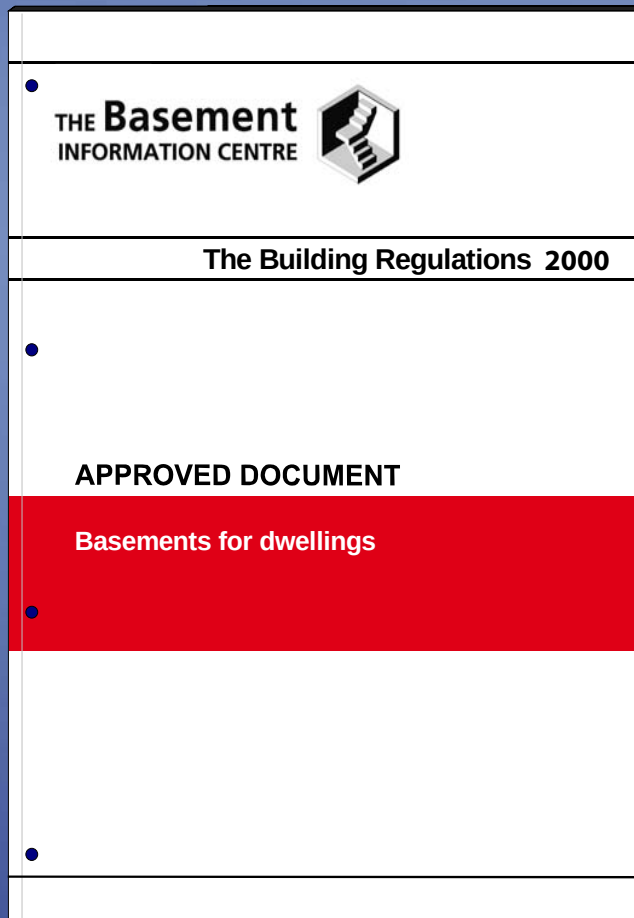
Basement under part of area of house



# Other Design Issues

|                                   |
|-----------------------------------|
| • The Basement INFORMATION CENTRE |
| The Building Regulations          |
| •                                 |
| APPROVED DOCUMENT                 |
| Basements for dwellings           |
| •                                 |
| •                                 |

# 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

B Regs  
part

- Site preparation and resistance to moisture
- Structure
- Fire safety
- Conservation of fuel and power
- Ventilation
- Resistance to the passage of sound

C

A

B

L

F

E



# Contents Contd

**B Regs  
part**

- **Stairs, ramps and guards**
- **Glazing - materials and protection**
- **Drainage and waste disposal**
- **Heat producing appliances**
- **Vehicle access**

**K**

**N**

**H**

**J**

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## **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**
- 



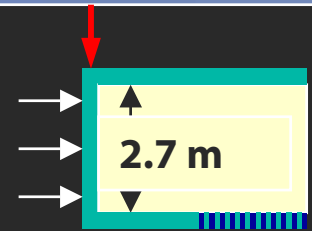
# **'Structure'**

**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**



| Foundation type | Soil type (well drained) | Vertical load (kN/m) up to<br>↓ | Moment taken at base of wall (kN/m) | Block comp. strength (N/mm <sup>2</sup> ) | Brick comp. strength (N/mm <sup>2</sup> ) | Area of reinforcement $A_s$ (mm <sup>2</sup> /m) |
|-----------------|--------------------------|---------------------------------|-------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------------------------------|
| Strip           | Clay                     | 70                              | 17                                  | 7                                         | 20                                        | 530                                              |
|                 | Granular                 |                                 | 12                                  | 7                                         | 20                                        | 340                                              |

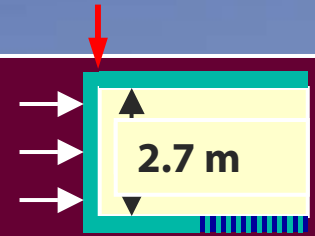
▪ Table in AD also covers raft foundation and different vertical load

▪ Similar tables for 2.1 m and 1.6 m cantilevered walls



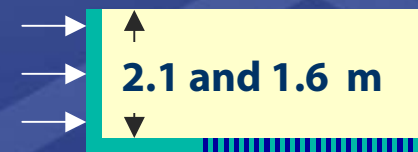
# Insitu concrete retaining walls

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

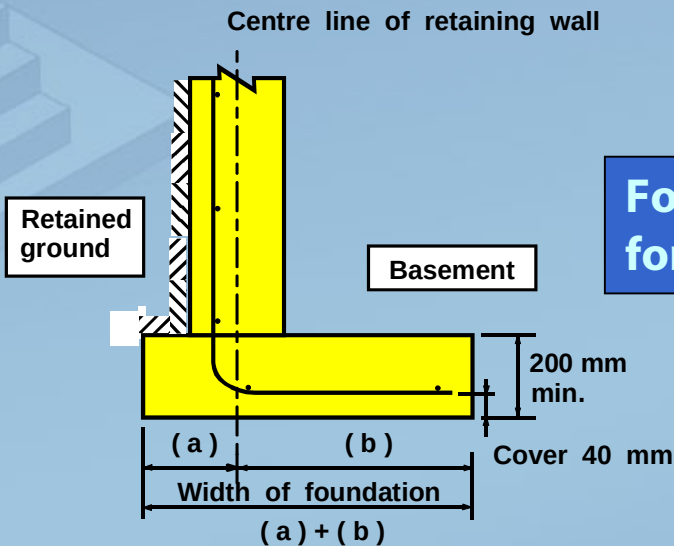


| Foundation type | Soil type (well drained) | Vertical load (kN/m) up to<br> | Moment taken at base of wall (kN/m) | Area of reinforcement $A_s$ (mm <sup>2</sup> /m) |      |
|-----------------|--------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------------------------------|------|
|                 |                          |                                                                                                                 |                                     | Wall thickness (mm)                              |      |
|                 |                          |                                                                                                                 |                                     | 200                                              | 300  |
| Strip           | Clay                     | 70                                                                                                              | 17                                  | 420                                              | 390* |
|                 | Granular                 |                                                                                                                 | 12                                  | 290                                              | 390* |

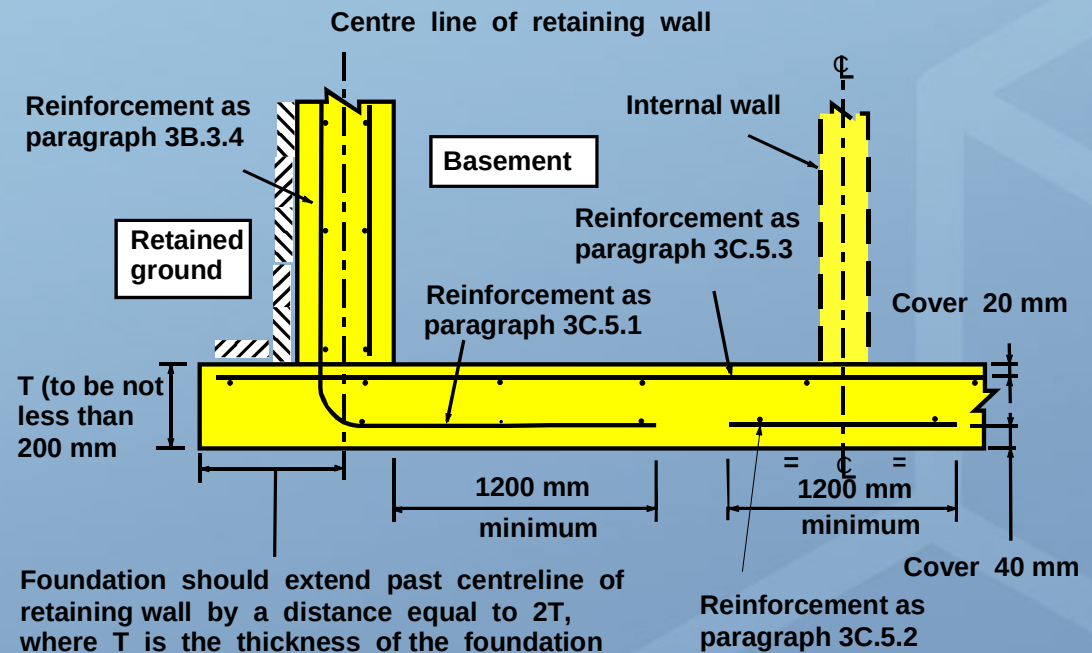
- Table in AD also covers raft foundation and different vertical load
- Similar tables for 2.1 m and 1.6 m cantilevered walls



## Foundation requirements for strip foundation



## Requirement for raft foundation



# '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

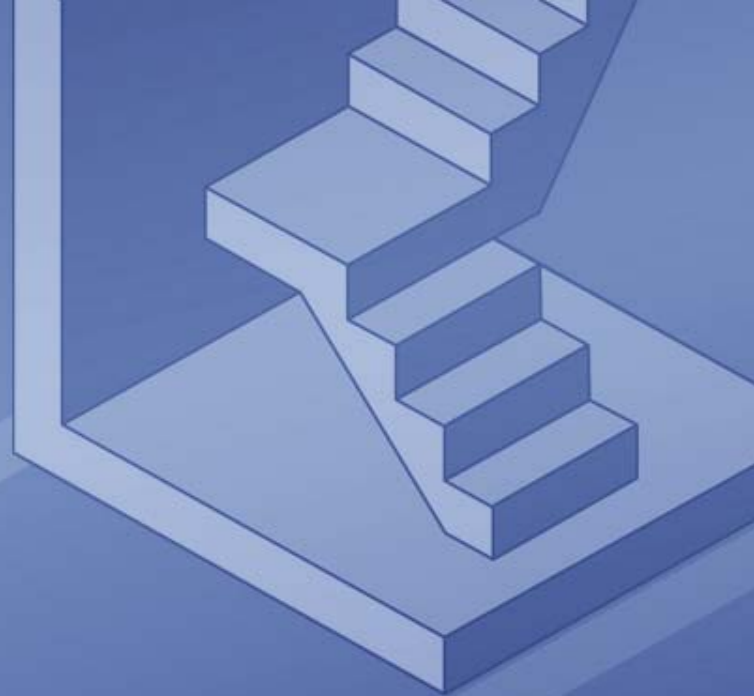
- ❖ Available information, Inc AD Basements
- ❖ Grades of construction , Construction options
- ❖ Design and waterproofing issues
  - Structure  
Waterproofing  
Repair
  - Adopt simple details
- ❖ Approved Document – 2004
  - Simplifies design for walls, and foundations  
and aids reliability

**And so to the finished project**



**By simplifying the design**

# Building into the Basement



Office of the  
Deputy Prime Minister  

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Creating sustainable communities

**BRE**

THE **Basement**  
INFORMATION CENTRE

