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Foreword

I'm delighted to introduce NHBC Chapter 5.4 'Waterproofing of basements and other below ground structures'.

Readers will be aware that, in 2013, NHBC launched a basement campaign highlighting significant issues with the design and construction of basements. Between 2005 and 2013, claims related to waterproofing below ground cost NHBC in the region of £21 million and affected around 890 homes.

The introduction of the new Chapter is a key component in NHBC's drive to improve basement construction.

The range of structures that require waterproofing goes significantly beyond what readers might typically consider as 'basements'. Below ground constructions that generally require waterproofing, and should take account of the new Chapter, include:

- basements
- semi basements
- below ground parking areas
- lift pits
- cellars
- storage or plant rooms
- service ducts or similar that are connected to the below ground structure
- stepped floor slabs where the step is greater than 150mm.

Near to ground constructions that may require waterproofing include:

- external walls where the lowest finished floor level is less than 150mm higher than the external ground level.

In order to help facilitate these changes, the new Chapter will become effective only when included in the re-launch of NHBC Standards, due to be published in 2015. However, while the Chapter will not become effective immediately, it is strongly recommended that the guidance is adopted at the earliest opportunity.

Mark Jones
Head of House-Building Standards

NHBC STANDARDS

Introducing Chapter 5.4
Waterproofing of basements and other below ground structures

Who should read this: Technical and construction directors and managers, architects, designers and site managers.

INTRODUCTION

In 2013, NHBC launched a Basement Campaign highlighting significant issues with the design and construction of basements. Between 2005 and 2013, claims related to waterproofing below ground cost NHBC in the region of £21 million and affected around 890 homes.

A key component of the campaign is the introduction of Chapter 5.4 'Waterproofing of basements and other below ground structures'. The new Chapter introduces meaningful benchmarks and supporting technical guidance for a range of situations where the structure is required to resist the ingress of water from the ground and other sources, where 'normal' waterproofing arrangements are not considered appropriate.

If you are designing or constructing such buildings, you will need to refer to the new Chapter.

REQUIREMENTS

The need for change

Following house price increases and limited availability of land, it is not surprising that we are seeing more below-ground accommodation; especially within our major cities. With this current boom in basements, and the frequency of below-ground waterproofing claims to registrations being circa 1600 times greater than foundation-related claims, below-ground construction remains a cause of concern to NHBC and the house-building industry.

Although the Standards have contained guidance for basements for many years (Chapter 5.1 'Substructure and ground bearing floors'), with increased use future predictions about heavier rainfall and rising water tables, we believe that now is the right time to expand on this guidance and ensure that the waterproofing of below ground structures is sufficiently robust to meet the high demands placed upon it. To help the industry achieve much needed improvement in this area, we have thoroughly reviewed our risk management processes, a significant element of which is the development of the new Standards Chapter 5.4.

We engaged with the house-building industry to develop new standards for technical performance atogether with guidance on how to achieve them. This has resulted in the new Chapter, which introduces standards that are practical, and robust, and which align with industry good practice.

Basement waterproofing failure

Design and construction requirements

Chapter 5.4 explains where waterproofing may be required, and where the new Chapter applies. Structures requiring waterproofing range from those where the external ground levels have been raised around the perimeter to within 150mm of the internal floor finish, to deep basements where there may be several levels below ground, and include any other structure near to or below ground level where waterproofing may be required.

REQUIREMENTS (CONTINUED)

Below ground constructions that generally require waterproofing include:

- basements
- semi basements
- below ground parking areas
- lift pits
- cellars
- storage or plant rooms
- service ducts or similar that are connected to the below ground structure
- stepped floor slabs where the step is greater than 150mm.

Near to ground constructions that may require waterproofing include:

- external walls where the lowest finished floor level is less than 150mm higher than the external ground level.

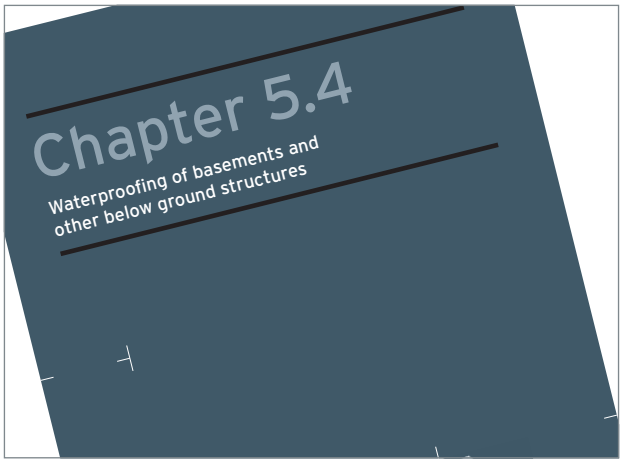
Design

Robust design should be undertaken by suitably qualified waterproofing experts, and be suitable for the specific ground and building conditions. The design should:

- be undertaken by a suitably qualified specialist who has obtained the Property Care Association 'Certified Surveyor in Structural Waterproofing' qualification
- be appropriate to the level of risk - where waterproofing is to a part of the structure forming a space where 'Grade 3 protection' is required (habitable accommodation) and more than 600mm of ground is being retained, a combined system comprising two types of waterproofing should be used
- consider the likely ground conditions - where the waterproofing is to more than 15% of the perimeter of the building or more than 600mm high, an appropriate investigation of the ground conditions should be undertaken.

Materials

Only systems, including important ancillary components, which have been assessed and proven to provide suitable performance in a given situation should be used. Waterproofing should:



- be independently assessed in accordance with Technical Requirement R3 (the assessment should consider all critical ancillary components
- include backup systems where pumps are used.)

Sitework

Recognising the importance of ensuring correct installation in accordance with the manufacturer's recommendations, waterproofing should only be undertaken:

- by operatives who are suitably trained or qualified
- using proprietary components to form complex changes in direction of the waterproofing and service penetrations.

The new Chapter will introduce significant positive change in the way the house-building industry considers below ground waterproofing. This will include an upskilling of designers and installers, and changes to future designs. In order to help facilitate these changes, the new Chapter will become effective only when included in the re-launch of NHBC Standards, which is expected in 2015. However, while the Chapter will not become effective immediately, it is strongly recommended that the guidance is adopted at the earliest opportunity.

By following the guidance and meeting the performance standards, we are confident that construction quality and robustness of below ground waterproofing will improve significantly, resulting in reduced need for remedial works, cost and disturbance for homeowners.

YOU NEED TO...

- Read the new Chapter and understand where it applies to you.
- Apply the revised guidance at the earliest opportunity.
- Consider the likely ground conditions - it may be necessary to establish the likely level of the water table and undertake long-term water level monitoring.
- For habitable accommodation where more than 600mm of ground is being retained, use a combined system comprising two types of waterproofing.
- Include backup systems where pumps are used.
- Ensure that you are suitably prepared for when the Chapter becomes effective.

For **technical advice and support**, call **01908 747384** or visit **www.nhbc.co.uk**

GUIDANCE AND GOOD PRACTICE

The basement pilot

Who should read this: Technical and construction directors and managers, architects, designers and site managers.

INTRODUCTION

Below ground structures are a difficult area to inspect; a lot of critical stages are covered up during the build prior to, or in between, NHBC building inspector visits. The basement pilot provides the builder/site personnel with an opportunity for additional support, supplementary to the standard Key Stage Inspection and Frequency

GUIDANCE

In May 2014, NHBC introduced the basement pilot as a soft launch on 20 selected sites. The pilot has explored opportunities for using supplementary photographic evidence and communication processes within the basement risk management process to:

- increase focus
- improve communications
- gain better control of high-risk elements
- provide a framework to capture areas that may have been previously missed.

The pilot introduces a facility for using photographic evidence supplementary to the standard inspection process. It also provides the builder with additional support from our NHBC building inspectors. The NHBC building inspector will review any submitted photos (by site staff) remotely and respond with their review/guidance within 24 hours, identifying any potential risks before they are covered up.

Submission stages will depend on the size of build/type of basement and will be confirmed in detail by the building inspector in a pre-start meeting.

The main aim of the pilot is to provide site staff with additional support to help drive up standards and reduce basement defects going forward.

The pilot has been a great success and well received from participating builders. The NHBC building inspectors and special risk project managers have been able to work more closely with builders throughout the basement build stages. Based upon the photographic evidence, the NHBC team has been able to provide clear guidance and, in return, help prevent water ingress failures in several cases, saving potentially tens of thousands of pounds.

YOU NEED TO...

If you are registering a basement or below ground structure that requires waterproofing and would like to participate in the pilot and gain free supplementary support, please email your details to technical@nhbc.co.uk.

For **technical advice and support**, call **01908 747384** or visit **www.nhbc.co.uk**

GUIDANCE AND GOOD PRACTICE

An industry perspective

Who should read this: Technical and construction directors and managers, architects, designers and site managers.

INTRODUCTION

The Property Care Association (PCA) – the national trade body representing the UK's structural waterproofing sector – has provided expertise and insight to the development of NHBC's Chapter 5.4 'Waterproofing of basements and other below ground structures'.

In this article, Steve Hodgson, Chief Executive of the PCA, explains why he is confident that the new Chapter will see a significant reduction in waterproofing failures, and why he believes it will also spark growing confidence in the use and creation of underground spaces, which in turn will be well received by developers, contractors, homeowners and insurers.

GUIDANCE

In our experience, the main causes of failed waterproofing are simple. Often, systems are poorly designed and/or poorly executed. At the heart of both these issues is a basic lack of appreciation that even the smallest defect can lead to problems that are both difficult to trace and expensive to repair.

It is critical, then, that underground waterproofing is tackled by designers that understand ground conditions, the challenges of the site and the complexity of the build, as well as considering the final performance requirements of the underground space.

Furthermore, the teams applying, installing and building the underground space must be fully aware of the critical nature of what they are doing, the importance of accuracy and the implications of any errors.

Research conducted by NHBC found that tanking defects have been the most common cause of basement claims since 2006 and that, in the vast majority of cases, claims were due to water ingress as opposed to structural defects. Twenty-eight percent of sites surveyed in 2012 had either high or unknown water tables, yet proposed Type A – 'tanking or barrier systems' or Type B – 'integral waterproofing' only as a method of construction.

It is unlikely that either of these methods on their own would have been suitable in such a situation, highlighting the need for improved advice and standards covering all methods of construction. The recommendation within the new Chapter that primary waterproofing should be combined with a second layer of protection is one that delivers robust and reliable, waterproof buildings.

It has long been the view of the PCA that the waterproofing system should be selected and designed to reduce risk and minimise the chances of failure. This ethos is now supported by NHBC's new Chapter, which looks to ensure that any waterproofing project includes input from a waterproofing design specialist and builds on the recommendation of British Standard BS 8102.

For **technical advice and support**, call **01908 747384** or visit **www.nhbc.co.uk**

GUIDANCE (CONTINUED)

The PCA

Of particular note for the house-building industry is the PCA Register of Waterproofing Design Specialists, a pool of vetted and approved professionals with specialist knowledge and qualifications who are able to make recommendations and carry out the waterproofing design specialist role.

The PCA offers a range of support to the construction sector to enable building professionals to meet the required standards of skill and competence set out under the new Chapter, which also aids confidence in the industry and underpins best practice.

Through the Register, developers, architects and builders can easily locate individual, competent practitioners who can assist in the design and planning of underground waterproofing. The register is available to view at: **www.property-care.org/ProGuidance.RWDS.asp.**

The PCA has delivered training and an industry qualification to companies and individuals who specialise in below ground waterproofing for more than 15 years, and NHBC are very pleased that this has been recognised in the new Chapter.

We are delighted to have been able to play a part in the drafting of the new waterproofing Chapter and to assist NHBC, which has proactively worked across the sector to form a cross-industry committee with a focus on the key issues affecting waterproofing in the UK – with a remit to help shape a new set of standards.

Chapter 5.4 heralds a new approach for the waterproofing industry, which will ultimately improve outcomes for clients, builders, insurers and homeowners.

YOU NEED TO...

This article is for general interest only. There are no actionable requirements.

GUIDANCE AND GOOD PRACTICE

Good practice case study
Basement waterproofing design and construction

Who should read this: Technical and construction directors and managers, architects, designers and site managers.

INTRODUCTION

The new Standards Chapter, 'Waterproofing of basements and other below ground structures', covers a wide range of homes. Here, we discuss how waterproofing issues have been addressed on a prestigious new build property in Wentworth, which includes an impressive 1500m^2 basement incorporating a swimming pool and underground parking. A sloping site and challenging ground conditions necessitated extensive ground works and a high-quality waterproofing system.

This case study considers a large property with extensive engineering works. Take note of the waterproofing principles adopted; they can apply equally to a range of situations and developments, both large and small.

GUIDANCE

Design

Designing a waterproofing system for such a complex property requires a high degree of certainty. Extensive site investigations were undertaken, not just for contamination and soil parameters but also for below ground waterproofing design and water risk management aspects.

The waterproofing design was undertaken by a waterproofing specialist, holding the PCA's Certificated Surveyor in Structural Waterproofing (CSSW) qualification. With the knowledge of potential ground water above the basement formation level, the surveyor designed the following:

Performance grades
The car park and habitable areas of the basement were designed for BS 8102:2009 Grade 3. 'No water penetration or dampness permitted.'

Type of waterproofing system
Below ground structure (basement) Combined System Type B & C - Structural water tight concrete and internal drained cavity. Podium Slab Combined System Type A & B - Structural water tight concrete with a liquid applied membrane above.

Below ground structure waterproofing concept
The designed reinforced concrete structural waterproofing barrier will allow very little water ingress to occur. With a combined system, the Type B barrier is backed up by the type C drained cavity system. Any water ingress or condensation that does occur will be collected and drained away by the type C system, a relatively fail-safe solution.

GUIDANCE (CONTINUED)

This case study focuses on the below ground structure, excluding the podium slab waterproofing.

Basement construction

Excavation

Following demolition of the original building, extensive ground works commenced with the installation of a secant piled retaining wall and reinforced concrete head beam at the rear of the basement.

Approximately 10,000m^3 of soil was excavated to form the basement. During excavation, further temporary sheet piles were installed on the returns of the basement.

Excavating to basement formation level, secant piled retaining wall to right hand side

Type B perimeter barrier construction

Raft/pad foundations

On excavating to basement formation level, localised RC column pad foundations and required basement drainage was installed. A nominal blinding layer of unreinforced concrete was placed over the remaining area ready for the raft reinforcement and shuttering.

The in-situ RC structure was designed to BS EN 1992-3:2006. Reinforcement was placed as per the design to restrict crack widths to less than 0.2mm.

The raft was poured, allowing for shrinkage, in approximately 60m^2 sections with a monolithic elevated perimeter kicker. Active physical movement joint waterbars were installed on all day work joints between pours. All services passing through the structure were physically sealed with a flange joint around the pipes.

Service penetration flange joint

Wall construction

Up to two storeys of formwork was constructed, keying off the monolithic kickers. Kickers were scabbled and cleaned; high-grade hydrophilic water bars were installed to seal gaps at kicker levels and other construction joints. On stripping the shutters, the concrete was visually checked for any blemishes. Where required, blemishes were post-injected. Temporary tie bar locations were made good by filling with a hydrophilic polymer sealant.

Good practice case study
Basement waterproofing design and construction

GUIDANCE (CONTINUED)

Type C internal drained cavity construction

To ensure quality of installation, the internal drained cavity system was installed by a manufacturer-approved contractor.

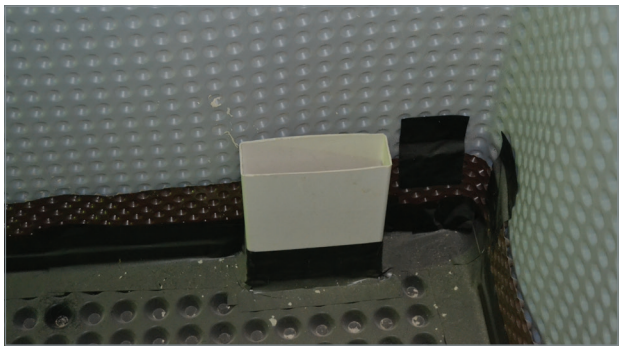
Wall membrane

First, the concrete wall was treated with a lime inhibitor and then the cavity membrane was installed to all perimeter walls. Membrane studs were placed against the prepared substrate. Fixing holes were drilled through the base of the membrane studs at pre determined centres. Proprietary quick-seal plugs were then driven into the concrete substrate to fix the cavity drain membrane into position. Grommits provide an effective seal between the head of the plug and cavity membrane. At the bottom internal face of the membrane, a condensation strip was fitted, collecting any potential internal condensation.

Drainage channels and floor membrane

The drainage membrane is not capable of resisting water pressure; therefore, to allow for direct drainage, a proprietary preformed drain channel was installed around the perimeter of the basement. The channel was connected to the sump area with flushing points at each change of direction.

Closed cell insulation was fitted around the drainage channels, bringing the overall floor level to the top of channel level. The cavity drain membrane was placed on the floor, butted up against the perimeter wall condensation strip. A corner strip tape was then used to seal the wall condensation membrane to the floor membrane. The floor membrane was covered with a mesh reinforced screed. The wall membrane then had battens fixed within the quick-seal plugs, ready for plastering or other internal finishes.



Newton S500 Cavity Drain flushing points

Newton S500 Cavity Drain waterproofing system, courtesy of Newton Waterproofing Systems

GUIDANCE (CONTINUED)

Main drainage and service plan

The drained cavity channels collect water and drain to the sump. The sump was cast within the monolithic raft and connected by drainage to the main drains with a non-return valve at the outlet. The invert level of the main drains was above the formation level of the sump; therefore, any water penetrating the structure is collected and drained away using a dual sump pump.

The pump was fitted with a backup generator and interactive alarm to ensure that, should a failure occur, occupants are fully aware of the issue.

To ensure long-term success of the system, a post-construction maintenance plan for the system and its discharge points was agreed.

YOU NEED TO...

Consider the waterproofing principles highlighted in this case study; they apply to a range of situations and developments, both big and small.

Useful contacts for technical information and advice

NHBC technical advice and support

Tel: 01908 747384
Email: technical@nhbc.co.uk
Web: www.nhbc.co.uk/builders/technicaladviceandsupport

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Building Regulations

For guidance on issues relating to Building Regulations, please visit NHBC's TechZone at www.nhbc.co.uk/techzone

Building Control

For Building Control queries, please call 0844 633 1000 and ask for **'Building Control'**, or email buildingcontroladmin@nhbc.co.uk.

Engineering queries

For Engineering queries, please call 0844 633 1000 and ask for **'Engineering'**.

NHBC Foundation research

The NHBC Foundation facilitates research and shares relevant guidance and good practice with the house-building industry.

www.nhbcfoundation.org

Training

For information about training, please go to www.nhbc.co.uk/training, call 0844 633 1000 and ask for **'Training'**, or email training@nhbc.co.uk.

The Zero Carbon Hub

The UK Government has set out an ambitious plan for all new homes to be zero carbon from 2016. The Zero Carbon Hub helps you understand the challenges, issues and opportunities involved in developing, building and marketing your low and zero carbon homes.

www.zerocarbonhub.org

NHBC Clicks & Mortar e-newsletter

NHBC regularly distributes information on a range of industry topics, including new products and services, the building industry market, house-building news and house-building statistics. To receive this industry information, please register at:

www.nhbc.co.uk/newsandcomment/registerfore-news

General enquiries

For all other enquiries, including ordering products and services, please call 0844 633 1000, and ask for **'Sales'**.

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