



# Ground Heave Solutions





## Who are Cordek?

Cordek provides technical solutions for a range of construction requirements. Innovative thinking, engineering expertise and extensive CAD/CAM capabilities enable Cordek to solve a wide variety of engineering problems. Since our formation in 1973, we have worked on major iconic projects through to domestic extensions and remain committed to supplying the best quality, value solutions, supported by the highest levels of personal service.

Through a combination of research and development, coupled with identifying the problems faced by designers and contractors alike, Cordek has developed a range of products suitable for providing ground heave protection to buildings and structures.

## What is Ground Heave?

Ground Heave is mostly caused by the rehydration of expansive soil types, predominantly clay, typically when building near existing trees or those that have recently been removed. Additional causes of Ground Heave include permafrost and overburden recovery which is associated with deep excavations e.g. basement construction.

## Cordek's Ground Heave Solutions

Cordek's Ground Heave Solutions consist of a comprehensive range of products including Cellcore HX, Cellcore HG, Cellform HX, Cellvent HX and Heaveguard which provide ground heave protection with additional features such as integral insulation, permanent formwork and passive gas venting. Each product is designed for use in a specific location within the foundation construction.



## Summary of Solutions

### Ground Heave

#### Cellcore HX + HG

A range of products designed to protect buildings and structures from the effects of ground heave.



### Ground Heave and Thermal Insulation

#### Cellcore Plus

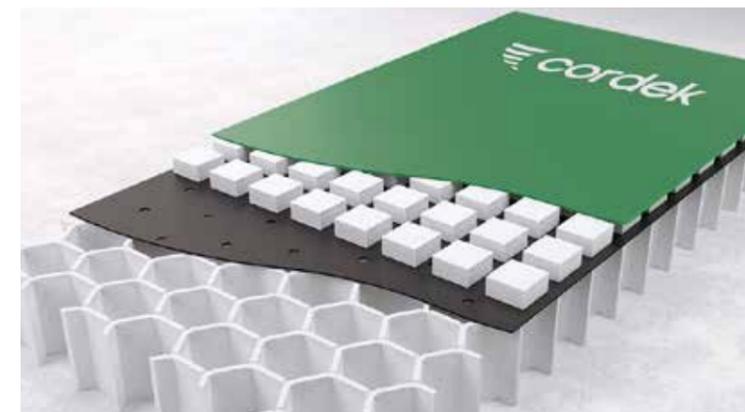
A heave protection product with integral insulation designed to meet the specific thermal requirements of a building.



### Ground Heave and Ground Gas

#### Cellvent HX

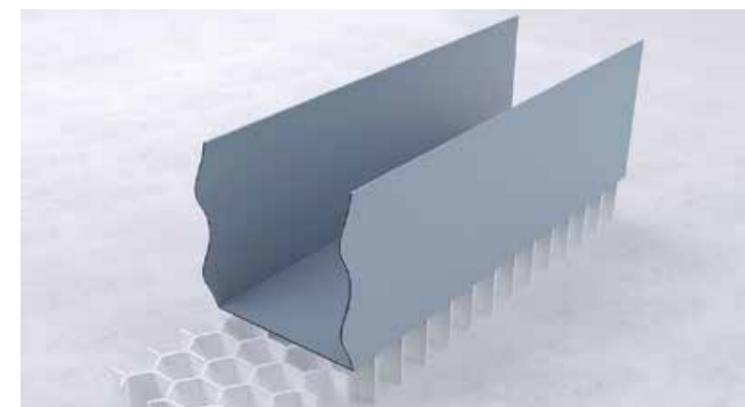
Designed for use where both heave protection and passive sub-floor ventilation of ground gases is required.



### Ground Heave and Permanent Formwork

#### Cellform HX

Heave protection with integral formwork for use beneath cast in situ concrete ground beams.





## Ground Heave Cellcore HX + HG

Cellcore HX is Cordek's fourth generation collapsible void former and has been designed to protect foundations from the effects of ground heave. The product consists of a cellular construction of Filcor EPS (Expanded Polystyrene) which has been designed, moulded and tested to tight tolerances to achieve the specified performance characteristics.

### Key features of this product range include:

- It reduces the upward force transmitted to the structure
- Available in a wide range of profiles and grades to suit most applications
- BBA certified

- Meets the NHBC Technical Standards
- Moulded production for enhanced and consistent performance

### Product Specification

Firstly the depth of the Cellcore HX panel should be determined by the heave potential of the soil, as detailed in **Table 1**.

Secondly, the grade of the product is determined by the depth of the concrete to be cast on the Cellcore HX panel, as detailed in **Table 2**.

Table 1: Cellcore HX Depth Selection Table

Results of Soil Analysis	NHBC Category	Predicted ground heave or BRE / NHBC Clear Void Requirement	Depth of Cellcore HX Required to Achieve 'Equivalent Void'	
			HX S (mm)	HX B (mm)
Plasticity Index	Volume Change Potential	Void Dimension (mm)		
10 - 20	Low	50	90	85
20 - 40	Medium	100	160	155
40 - 60	High	150*	225	220

\* Where the predicted ground heave is in excess of 150mm please contact the Cordek Technical Team.



Table 2: Cellcore HX Grade Selection Table

Grade*	Safe Load (kN/m <sup>2</sup> )	Fail Load (kN/m <sup>2</sup> )	Maximum Concrete Depth** (mm)
7/10	7	10	220
9/13	9	13	300
13/18	13	18	460
18/24	18	24	660
24/32	24	32	900

\*For easy identification, the panel labels are coloured as shown.

\*\*Based on the Eurocode and a imposed load allowance of 1.5 kN/m<sup>2</sup>. Please contact the Cordek Technical Team where the depth of concrete exceeds 900mm.

For concrete thicknesses between 900mm and 2000mm, Cellcore HG panels are available – please refer to page 7 for further details.

## Definitions

### Safe Load

The maximum load which can be applied to the product during the construction process. This is calculated as the total dead weight of the concrete and reinforcement (assumed to be 25kN/m<sup>3</sup>) plus an allowance of 1.5kN/m<sup>3</sup> for the imposed load (foot traffic, heaping of concrete etc).

### Fail Load

The load at which the legs of the Cellcore panel will collapse if the ground heaves under the concrete structure. The slab, beam or pile cap must be designed to accommodate this upward load, taking in to account the self-weight of the concrete structure.



## Cellcore HX Design Examples



### Cellcore HX:

#### Key features of this product range include:

- Reduces the upward force transmitted to the structure from ground heave
- Wide range of profiles and grades to suit most applications
- Moulded production for enhanced and consistent performance
- Patented product technology
- BBA certified
- Meets the NHBC's Technical Standards

These product features can be found in each of the available variants of the Cellcore HX S and HX B ranges, which are intended for use beneath specific foundation types as indicated below:



### Example 1: Reinforced Concrete Slab (Heave Protection)

- Plasticity Index of 25
- Slab thickness of 450mm

#### Step 1. Determining BRE/NHBC Volume Change Potential

**Table 1** indicates that a plasticity index of 25 is within the NHBC 'Volume Change Potential' category of **Medium** and that an **equivalent void dimension of 100mm** is required.

#### Step 2. Identifying the correct depth of Cellcore HX panel

**Table 1** indicates that a **160mm deep Cellcore HX S** panel is required based upon the Medium Volume Change Potential / 100mm equivalent void dimension requirement.

#### Step 3. Determining the correct grade of Cellcore HX panel

**Table 2** indicates that a 450mm deep reinforced concrete slab requires a **13/18** grade of panel.

#### Step 4. Product Specification\*

Based upon the information provided above, the correct product specification is:

**Cellcore 160mm HX S 13/18**

#### Notes:

The slab must be suitably designed to accommodate the transmitted load and two possible modes of failure should be considered:

- The slab being lifted off the foundation
- Failure of the slab in bending or shear due to the residual uplift

### Example 2: Reinforced Ground Beam (Heave Protection)

- Plasticity Index of 50
- Ground Beam thickness of 600mm

#### Step 1. Determining BRE /NHBC Volume Change Potential

**Table 1** indicates that a plasticity index of 50 is within the NHBC 'Volume Change Potential' category of **High** and that an **equivalent void dimension of 150mm** is required.

#### Step 2. Identifying the correct depth of Cellcore HX panel

**Table 1** indicates that a **220mm deep Cellcore HX B** panel is required based upon the High Volume Change Potential / 150mm equivalent void dimension requirement.

#### Step 3. Determining the correct grade of Cellcore HX panel

**Table 2** indicates that a 600mm deep reinforced concrete ground beam requires an **18/24** grade of panel.

#### Step 4. Product Specification\*

Based upon the information provided above, the correct product specification is:

**Cellcore 220mm HX B 18/24**

#### Notes:

The beam must be suitably designed to accommodate the transmitted load and two possible modes of failure should be considered:

- The beam being lifted off the top of the piles
- Failure of the beam in bending or shear due to the residual uplift



### Cellcore HX S:

Cellcore HX S is designed for use beneath reinforced concrete floor slabs to protect against the potential effects of ground heave.

The HX S range of products are available in a variety of depths and grades to suit most commonly encountered combinations of soil heave potential and concrete depth.

### Cellcore HX B:

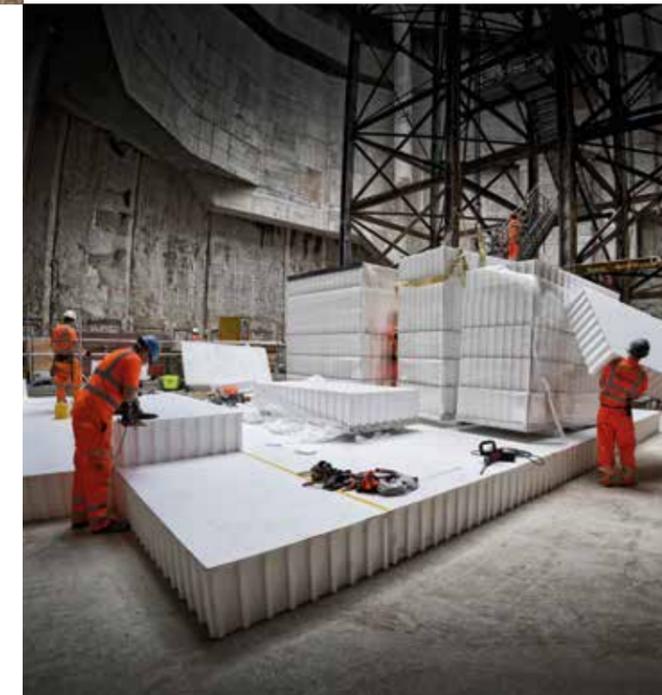
Cellcore HX B is designed specifically for use beneath reinforced concrete ground beams and pile caps.

The HX B range of products are available in a variety of depths, grades and can also be supplied in a range of widths to suit common ground beam and pile cap widths.

### Cellcore HG:

Cellcore HG is designed for use in ground heave protection applications, where the requirements of the project mean that the standard Cellcore HX product range is not suitable. Usual applications include the use beneath deep (in excess of 900mm) reinforced concrete slabs, ground beams and pile caps.

The Cellcore HG panels are available in a variety of depths and grades to compliment the standard Cellcore HX range. For further information please contact the Cordek Technical Team.



\*It is recommended to include installation guidance - please refer to page 14 for details.



## Ground Heave and Thermal Insulation

### Cellcore Plus

The Cellcore Plus product range is available in both HX and HG and is designed for use beneath reinforced concrete floor slabs to protect against the potential effects of ground heave with the additional benefit of providing insulation. The Cellcore Plus product consists of the same cellular construction of Filcor EPS (Expanded Polystyrene) bonded to a Filcor insulation layer protected by a thin polypropylene sheet; alternative insulation materials are available if required.

Cellcore Plus products are available in a variety of depths and grades to suit most commonly encountered combinations of soil heave potential, concrete depth and U-value requirements.

#### Key features of this product range include:

- Meets the thermal performance required under Part L of the building regulations for England and Wales and Section 6.2 of the building standards for Scotland
- Meets both the ground movement requirement and thermal requirements of a ground floor or basement floor slab in a single operation saving time and reducing costs
- Allows for the omission of insulation above the floor slab and therefore potentially an additional floor screed
- Due to its use below the floor slab it reduces the potential for damage to the insulation layer during the ongoing construction process

#### U-Value Calculation

In order to undertake a U-value calculation to determine the appropriate thickness of insulation to be incorporated within the Cellcore Plus panels, we will require the following information relating to the proposed floor slab:

- Floor area
- Exposed perimeter distance
- Floor build-up including any finishes (with dimensions)
- Wall build-up (with dimensions)
- Target U-value

#### Product Specification

Once the correct product depth and grade has been determined based upon the heave potential (see **Table 1**) and concrete depth (see **Table 2**), then the required Filcor EPS insulation thickness should be included in the product specification e.g Cellcore 160mm HX 9/13 Plus 50mm Filcor EPS.

Table 3: Cellcore Plus Thermal Performance Table

Thickness of Filcor EPS Insulation Layer (mm)*	Thermal Resistance m <sup>2</sup> c/w
50 (Standard)	1.39
75	2.08
100	2.78
125	3.47
150	4.17

\*Filcor EPS thicknesses in excess of 150mm are available, as are alternative insulation materials. Please contact the Cordek Technical Team for further information. In order to determine the correct thickness of Filcor EPS insulation to be incorporated within the Cellcore Plus panel, please contact the Cordek Technical Team for further assistance including the supply of project specific U-value calculations.





## Ground Heave and Ground Gas

### Cellvent HX

Cellvent HX combines the benefits of the Cellcore HX range with Ventform to alleviate the effects of ground heave whilst also providing an efficient gas venting medium. It is designed for use under suitably reinforced ground floor slabs where subsidence is not expected.

**Key features of this product range include:**

- Provides combined ground heave protection and gas venting capabilities in a single product, thereby saving time and reducing costs
- Range of thicknesses and grades to suit most project requirements
- Light, robust and easy to install panels
- Unaffected by both UV light and water

Cellvent HX is available in a range of specifications to accommodate the heave protection requirements of any particular project. The specification of the appropriate panel depth and grade is outlined in **Tables 4 and 5** respectively and a design example is provided for further guidance.

The passive venting capabilities of the Cellvent HX are based upon those of the Ventform 80 which has a clear void equivalent of 19mm. For further information regarding the Ventform product range please refer to the Cordek VOC and Ground Gas Protection brochure, which also includes details of gas membranes, vent outlets and venting accessories which can be used in conjunction with Cellvent HX to form a complete gas protection system.

### Product Specification

Firstly the depth of the Cellvent HX panel should be determined by the heave potential of the soil, as detailed in **Table 4**.

Secondly, the grade of the product is determined by the depth of the concrete to be cast on the Cellvent HX panel, as detailed in **Table 5**.

### Design Example 3: Reinforced Concrete Slab (Heave Protection & Passive Gas Venting)

- Plasticity Index of 15
- Slab thickness of 300mm

**Step 1: Determining BRE /NHBC Volume Change Potential**

**Table 4** indicates that a plasticity index of 15 is within the NHBC 'Volume Change Potential' category of **Low** and that an **equivalent void dimension of 50mm** is required.

**Step 2. Identifying the correct depth of Cellvent HX panel**

**Table 4** indicates that a **135mm deep Cellvent HX** panel is required based upon the Low Volume Change Potential / 50mm equivalent void dimension requirement.

**Step 3. Determining the correct grade of Cellvent HX panel**

**Table 5** indicates that a 300mm deep reinforced concrete slab requires a **9/13** grade of panel.

**Step 4. Product Specification**

Based upon the information provided above, the correct product specification is:

**Cellvent 135mm HX 9/13**

**Notes:**

The slab must be suitably designed to accommodate the transmitted load and two possible modes of failure should be considered:

The slab being lifted off the foundation

Failure of the slab in bending or shear due to the residual uplift

**Cellvent should only be used on sites where subsidence is not expected.**

Table 4: Cellvent HX Depth Selection Table

Results of Soil Analysis	NHBC Category	Predicted Ground Heave or BRE / NHBC Clear Void Requirement	Depth of Cellvent HX Required to Achieve 'Equivalent Void'
Plasticity Index	Volume Change Potential	Void Dimension (mm)	Panel Depth (mm)
10 - 20	Low	50	135
20 - 40	Medium	100	205
40 - 60	High	150*	270

\* Where the predicted ground heave is in excess of 150mm please contact the Cordek Technical Team.

Table 5: Cellvent HX Grade Selection Table

Grade*	Safe Load (kN/m²)**	Fail Load (kN/m²)**	Maximum Concrete Depth* (mm)
7/10	7	10	220
9/13	9	13	300
13/18	13	18	460
18/24	18	24	660

\* Based on the Eurocode and a imposed load allowance of 1.5 kN/m². Please contact the Cordek Technical Team where the depth of concrete exceeds 660mm. \*\* For definitions of Safe Load & Fail Load refer to page 5.



## Ground Heave and Permanent Formwork Cellform HX

Cellform HX combines the benefits of Cellcore HX B with an economical and simple to install permanent formwork system. Each Cellform HX panel is supplied to the required beam width and depth, allowing quick installation.

The principle of Cellform HX is that the hinged side panels are supported off the reinforcement cage by concrete spacers, which allows the excavation to be backfilled. The backfill supports the formwork against the concrete pressure whilst the beam is cast and thereby avoids the need for fixing and striking traditional formwork.

**Key features of this product range include:**

- Based upon the Cellcore HX B technology

- Specific beam widths and depths catered for
- Quick and simple to install
- Reduces concrete wastage

### Product Specification

The appropriate Cellform HX type can be determined based upon the depth (**Table 1**) and grade selection (**Table 2**) information provided on pages 4 and 5. Once this has been identified, the correct width and depth of the integral formwork should be specified based upon the dimensions of the proposed ground beam e.g Cellform 160mm HX 9/13 to suit 450mm x 450mm beam. **Table 6** below confirms the minimum and maximum ground beam dimensions that can be accommodated by the Cellform HX range.

Table 6: Cellform HX Integral Formwork Sizes

Ground Beam Dimension	Min (mm)	Max (mm)
Width	300	1200
Depth	300	900

## Heaveguard & Heaveguard Pile Collars

Heaveguard is a highly compressible low density Expanded Polystyrene (EPS) product used as an integral part of the Cordek solution to ground heave. Heaveguard is used to protect against lateral heave, typically on the inside face of piled ground beams or deep trench fill foundations.

**Key features of the product include:**

- Reduces the lateral force transmitted to the structure
- Wide range of sheet sizes and thicknesses to suit most applications
- Coloured green for easy identification on site
- BBA certified
- Meets the NHBC's Technical Standards

### Heaveguard Design Notes

- Heaveguard, and all similar compressible polystyrene boards, require a load of approximately 40 kN/m<sup>2</sup> to compress by 50%. For this reason Heaveguard is not recommended for use under ground floor slabs, piled beams or pile caps.

### Product Specification\*

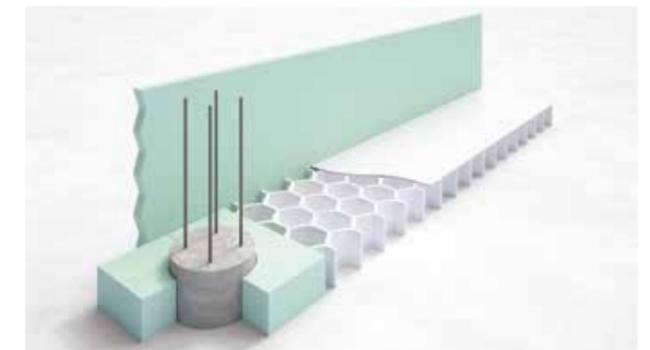
When determining the correct thickness of Heaveguard required the information provided in **Table 7** details the guidelines provided by the NHBC.

### Heaveguard Pile Collars

As an integral part of the Cellcore ground heave system, Heaveguard Pile Collars aid installation by fitting securely around the pile and providing a square edge for the Cellcore panels to be butted against. Heaveguard Pile Collars are available in a variety of different collar sizes and thicknesses.

**Key features of this product range include:**

- Aids installation of Cellcore panels
- Provides protection against ground heave
- Wide range of collar sizes and thicknesses to suit most applications
- Coloured green for easy identification on site
- Available for both round and square piles



\*It is recommended to include installation guidance - please refer to page 14 for details.

Table 7: Heaveguard Selection Table

Results of Soil Analysis	NHBC Category	Predicted Lateral Movement / NHBC Recommended Void*	Heaveguard Thickness for 'Equivalent Void**
Plasticity Index	Volume Change Potential	Void Dimension (mm)	Heaveguard (mm)
10 - 20	Low	-	-
20 - 40	Medium	25	50
40 - 60	High	35	75

\* Where the Predicted Lateral Movement is in excess of 35mm please contact the Cordek Technical Team.

# Installation Guidance



Table 8: Product Suitability Table

## Cellcore Installation Guidance

- Ensure that the panels are placed on a firm, level and well compacted surface. Typically a layer of concrete blinding beneath the panels is recommended.
- Individual panels should be butted together, with taping of the joints using formwork tape to avoid any grout loss between the panels.
- Do not overload, please refer to the maximum depth of concrete for each specific panel type detailed in **Table 2** of this document.
- Reinforcement spacers can be placed directly on the panels, although where a heavy reinforcement cage has been specified, a concrete blinding above the panels will help to spread the spacer load.

## Heaveguard Installation Guidance

- For piled ground beams, Heaveguard is generally only required on the inside face of external ground beams, as indicated in the NHBC guidelines.
- The Heaveguard sheets should be placed against the face of the ground beam after striking of the formwork and prior to backfilling. If a permanent formwork system is used to cast the ground beams then the formwork should be dimensioned such that the Heaveguard sheets will fit inside the former prior to concreting.
- For use in deep trench fill applications the excavation width should accommodate the width of the foundation and the thickness of the Heaveguard sheets specified. Care should be taken to ensure that the Heaveguard sheets are adequately supported so that they remain in the correct position during the placement of the concrete.
- Typically, the excavation will be founded 500mm below the zone of influence, and the Heaveguard sheets installed in accordance with NHBC requirements, i.e. 500mm above the bottom of the trench and on the inside face of the excavation.

Ground Heave Solutions	Protection against vertical heave under Floor Slabs	Protection against vertical heave under - Pile Caps & Ground Beams	Protection against horizontal heave down the sides of foundations	Integral Insulation	Gas Venting	Integral Formwork
Cellcore HX S	✓					
Cellcore HX B		✓				
Cellcore HG	✓	✓				
Cellcore Plus	✓			✓		
Cellvent HX	✓				✓	
Cellform HX		✓*				✓
Heaveguard			✓			

\* Suitable for ground beams only.

## Online Technical Resources

We have a full range of online technical resources to help you which can be accessed at [www.cordek.com](http://www.cordek.com) but if you need anything further or have any specific questions do not hesitate to get in touch with our Technical Team.

- Technical Library
- BIM Objects
- Data Sheets
- MSDS
- Standard Details
- NBS Specifications

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