

BUILDING  
COMMON GROUND



# Pecavoid®

Ground Heave Solution



[www.maxfrank.com](http://www.maxfrank.com)



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## Ground Heave Solution

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At MAX FRANK we pride ourselves on the friendliness and technical knowledge of our staff. As part of an international group we have over half a century of experience in reinforced concrete construction technology. Our UK-based team provides full customer support from application advice and design services, through to delivery and onsite support.

Our industry-leading products and solutions include **fibre concrete spacers**, **Pecafil®**, **Shearail®**, **Egcobox®**, **Stremaform®** and many other products for groundworks, concrete frame, waterproofing and concrete durability applications. Our ground heave solution, **Pecavoid®**, is at the heart of our range of formwork solutions.





# Pecavoid®

**Certified and proven ground heave solution**

**Creates a void beneath suspended slabs and beams**

**Top and bottom board solution available**

**Insulation can be incorporated**

**Does not degrade and contains no CFCs or HCFCs**

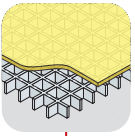
**Compatible with Pecafil® permanent formwork**



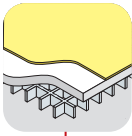
The above certificate applies to Pecavoid® cellular void formers up to 15/22 grade

**Slabs**

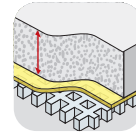
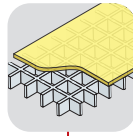
without insulation



with insulation

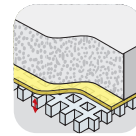


**Beams**



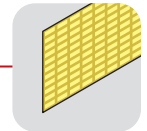
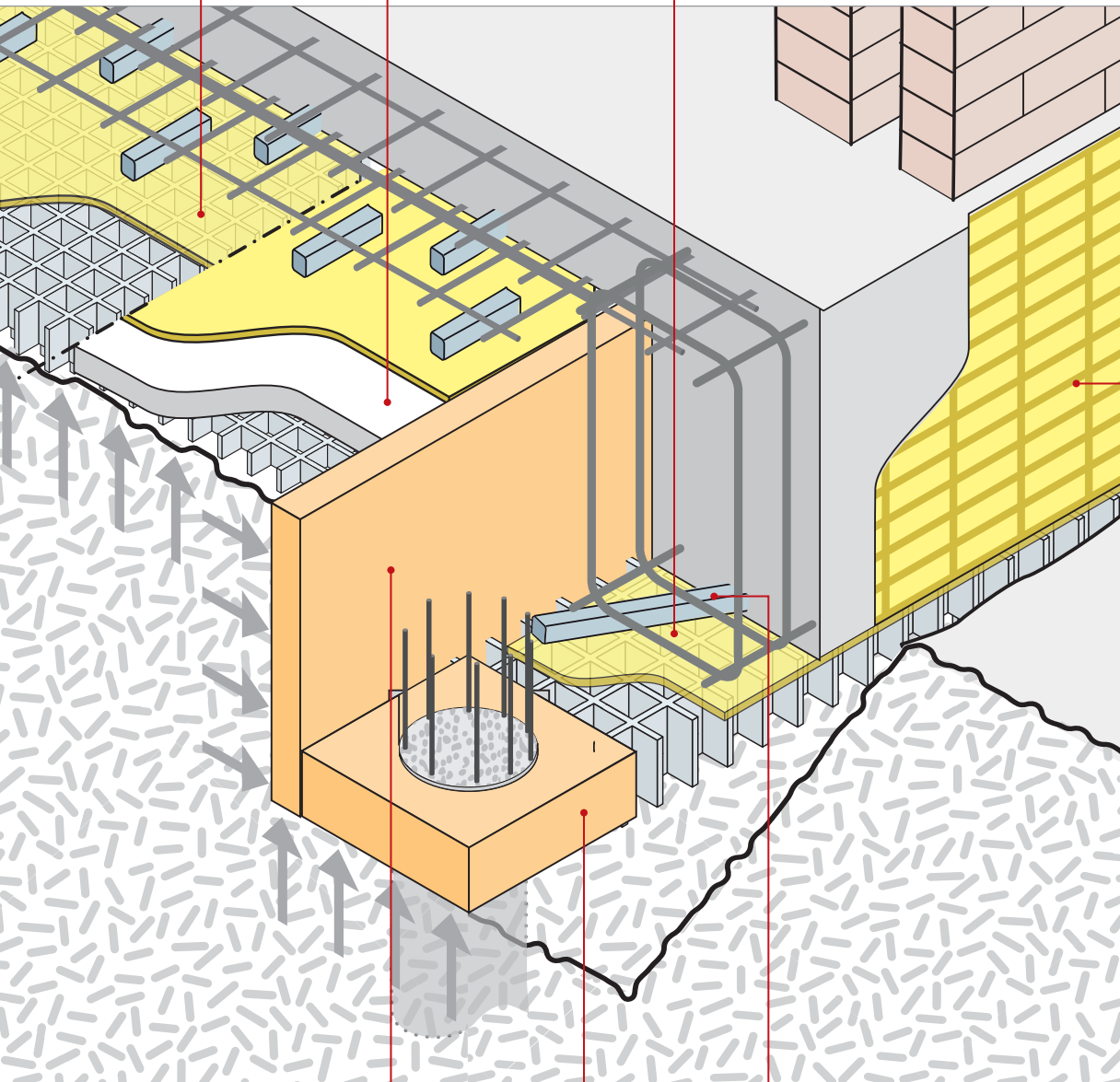
**Depth of slab or max. load**

< 1140mm: RD Range  
above: C Range

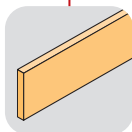


**Clear void thickness**

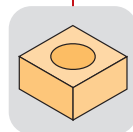
50 mm, 100 mm, 150 mm,  
or above



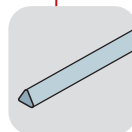
Pecafil®  
permanent  
formwork



Clayfill side  
protection  
board

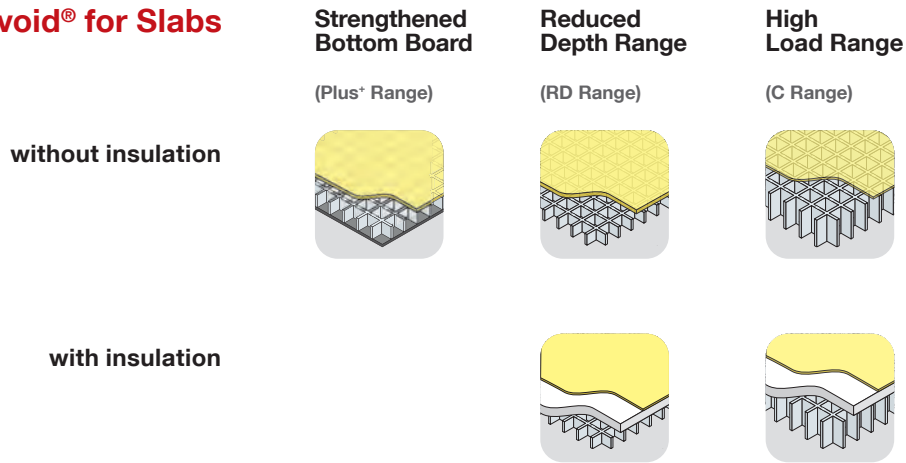


Pile Collars

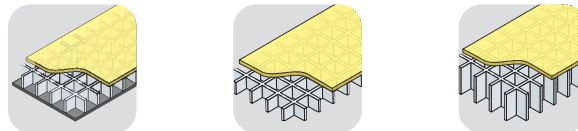


Fibre concrete  
spacers

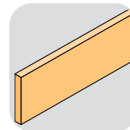
## Pecavoid® for Slabs



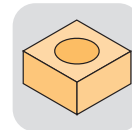
## Pecavoid® for Beams



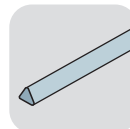
## Associated products



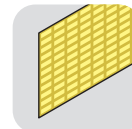
Clayfill side protection board



Pile Collars



Fibre concrete spacers



Pecafil® permanent formwork



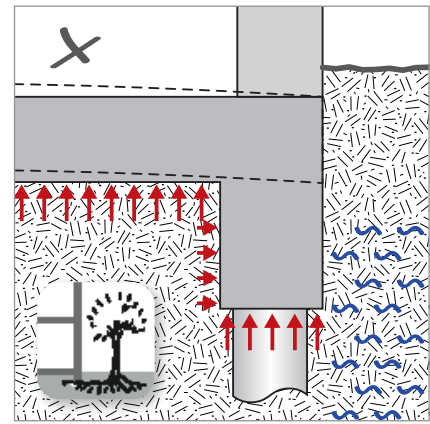
The above certificate applies to Pecavoid® cellular void formers up to 15/22 grade

## The Problem: Ground Heave

Expanding soils, such as clays are primarily affected by two factors;

- water content within the soil strata.
- environmental conditions which add or remove water from the soil, i.e. leaking drains or vegetation.

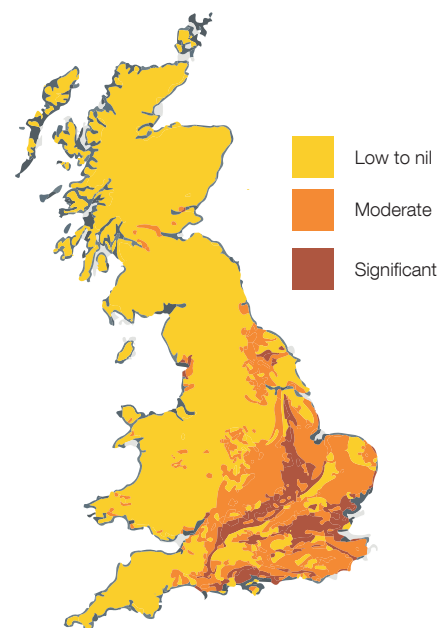
These conditions can cause dimensional changes in swelling clays. The results of which can impart large forces onto the structural element, sometimes moving a foundation, if not adequately protected.



## Causes of Ground Heave

In the UK ground heave is primarily caused by the rehydration of clay or expansive shale soils, overburden recovery resulting from deep excavations, mining or trees and vegetation. Whilst clay is a major problem throughout the South East and in isolated pockets nationally, ground heave due to other causes may be encountered in any region.

Plasticity Index PI (%)	Shrinkage Category	Vertical Movement Clear Void Dim. (mm) ↑	Lateral Movement Clear Void Dim. (mm) ↔
10 - 20 %	Low	50	0
20 - 40 %	Medium	100	25
40 + %	High	150	35



Map: Shrink-Swell potential UK.

## Ground Heave (Plasticity Index of Clay Soils)

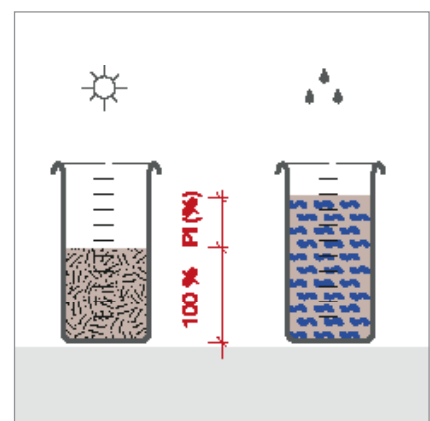
In most expanding soils the following affect soil conditions:

- The moisture content of a soil can alter its bearing capacity.
- Soil permeability greatly controls the amount of moisture kept within its interlocking pores.

Darcy's Law & Attenberg's Limit provide the base to determine the Plasticity index of the soil:

$$\text{Plasticity Index (PI)} = \text{Liquid Limit (LL)} - \text{Plastic Limit (PL)}$$

The resulting PI% ranges have been tabulated for easy use in documents such as NHBC's Chapter 4.2 Building Near Trees. These dimensional movements require consideration for any foundation design.



## Residual Uplift Force

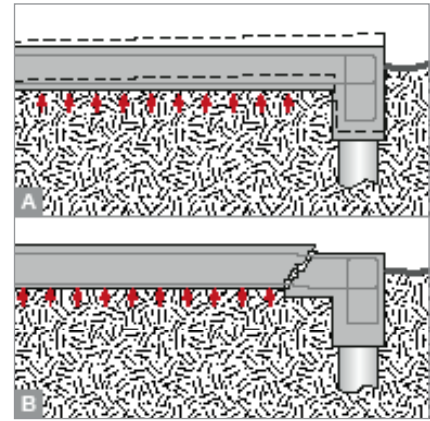
Following the design requirements of expanded clay soils, set out in Eurocode BS EN 1992-1-1:2004 & BS EN1990:2002 and the relevant National Annexes, any resultant calculated uplift force must be resisted by the building's, structural elements i.e. piles, pilecaps, ground beams and suspended slabs.

Failure to comply might result in:

**A** Slabs and beams lifting off the piles.

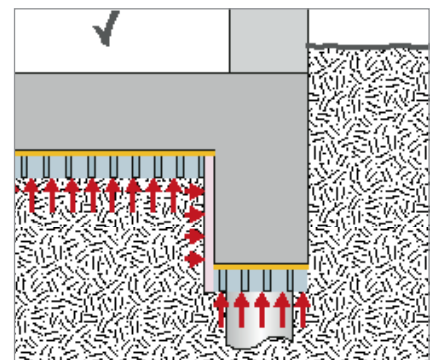
**B** Slab/beam connection would fail in shear.

The provision of MAX FRANK's Pecavoid®, as a protective layer between the soffit of the suspended foundation and the expanding clay soil, provides full protection during the complete life span of the building. The use of steel reinforcement within the structure ties the piles to ground beams, and ground beams to slabs, resisting uplift.



## The Solution: Pecavoid®

Ground heave protection to foundations is essential when building in ground that is affected by the above conditions. Pecavoid® and its associated ground heave products, when used in combination with a suspended foundation, i.e. pilecaps, ground beams and suspended slabs, help to alleviate these issues by creating a void. Pecavoid® can be supplied in a number of grades and depths designed to provide full foundation protection in any type of expanding soil situation.



## Pecavoid® Plus<sup>+</sup>

Pecavoid® Plus is the NEW feature, accepted by BBA, of the MAX FRANK RD (Reduced Depth) range – for minimal excavation depth. The top and bottom board solution increases rigidity of the product, where lower grades have been designed, for easier handling and improved performance onsite.

It is supplied for slabs (grades 08/12 up to 13/19) and beams (grades 09/13 up to 13/19).

## Safe Load / Fail Load

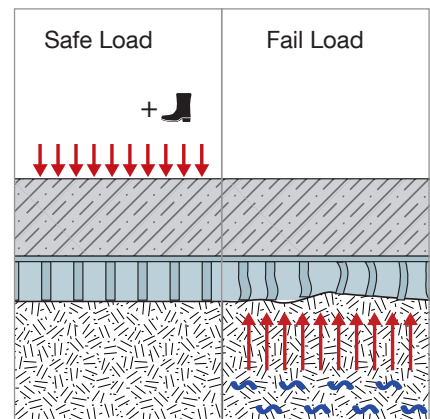
Each Pecavoid® grade indicates both its safe-load and fail-load capacity.

**Safe Load** = Wet concrete load  
+ 1.5 kN/m<sup>2</sup> live load allowance for practical working loads

**Fail Load** = Load from heave

Example: Pecavoid® Grade 13/19 (Safe-load 13 kN/m<sup>2</sup> & Fail-load 19 kN/m<sup>2</sup>)

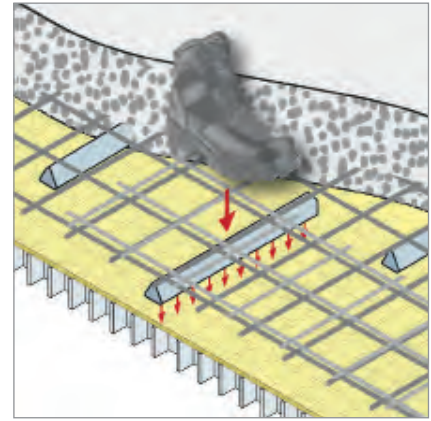
Pecavoid® is designed to withstand the specified safe-load for a designated period of time, with minimal creep during the concrete curing process. Pecavoid® is then designed to collapse when subjected to the forces of the heave with only a minimal force being exerted onto the suspended concrete structure above. This force is calculated using the residual uplift calculation.



## Temporary Loads during Construction

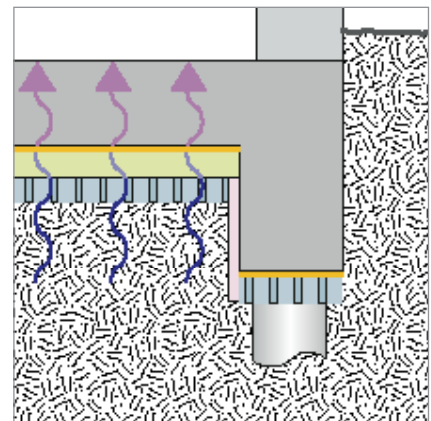
Owing to the technical requirements of Pecavoid® the product is relatively fragile and requires good handling and onsite storage. Care should always be taken when installing the product and certain criteria should always be met:

- A firm level surface must be laid prior to the installation of the Pecavoid® (preferably a concrete blinding layer).
- Before stepping on any lightweight Pecavoid® grades, place linear fibre concrete spacers on the product (to distribute the working loads of any foot traffic) in a staggered pattern. MAX FRANK recommend the use of walking boards, to spread the load due to foot traffic, whilst working on the Pecavoid® to lay any membranes or steel reinforcement.



## Insulation

Sometimes it's not possible to place slab insulation on top of the structural slab, owing to slab live loading requirements; so MAX FRANK have devised a product that meets all of the ground movement requirements, but with an additional insulation layer bonded to the product, which is placed under the slab. The type and thickness of the insulation layer can be modified to suit the thermal requirements of the building.



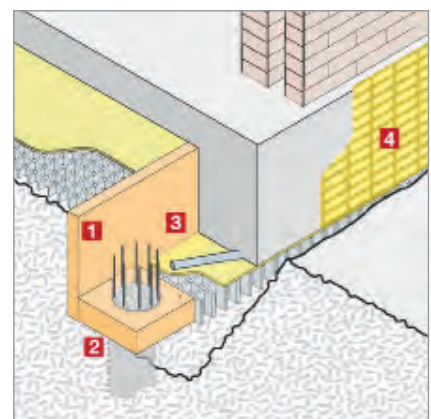
**Product Type (Thermal Conductivity)**

Thickness (mm)	Standard (0.036 W/mK)	Bronze (0.031 W/mK)	Silver (0.030 W/mK)	Gold (0.020 W/mK)
<b>Thermal Resistance</b>				
Standard 50	1.39	1.61	1.67	2.50
75	2.08	2.42	-	3.75
80	-	-	2.67	4.00
100	2.78	3.23	3.33	5.00
125	3.47	4.03	-	-
130	-	-	4.33	6.50
150	4.17	4.84	5.00	7.50

## Additional Products

In addition to Pecavoid® MAX FRANK also provide a full range of lateral and piling ground heave protection products:

- 1 Clayfill side protection board (protection against lateral ground movement)
- 2 Pile collars and pile sleeves (for easy installation around pile penetrations)
- 3 Spacers (for load transfer and installation with Pecavoid®)
- 4 Pecafil® permanent ground beam shuttering

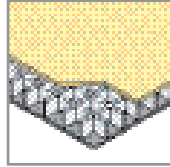




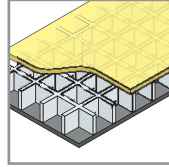
## Pecavoid® Plus+ - increased rigidity of reduced depth grades

Pecavoid® Plus+ is the new and improved ground heave solution from MAXFRANK. The integrated top and bottom boards improve the rigidity of the product during handling and installation for lower reduced depth grades for minimal excavation.

**Plus+ Slab**



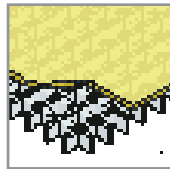
**Plus+ Beam**



## Pecavoid® RD Range – for minimal excavation depth

MAX FRANK's Pecavoid® RD Range (Reduced Depth) is available in various grades for concrete depths up to 1,140mm. There is a product that can be used under any suspended; ground beam, pilecap, raft or slab.

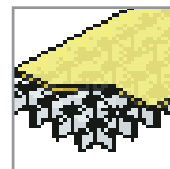
**Slab**



**Slab with insulation**



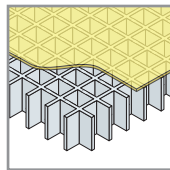
**Beam**



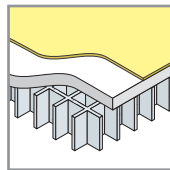
## Pecavoid® C Range – for high loads

The C Range is used for deep concrete suspended foundations and can be manufactured to offer ground heave resistance for up to and beyond 2m head of concrete.

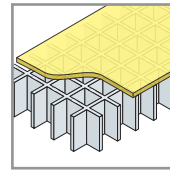
**Slab**



**Slab with insulation**

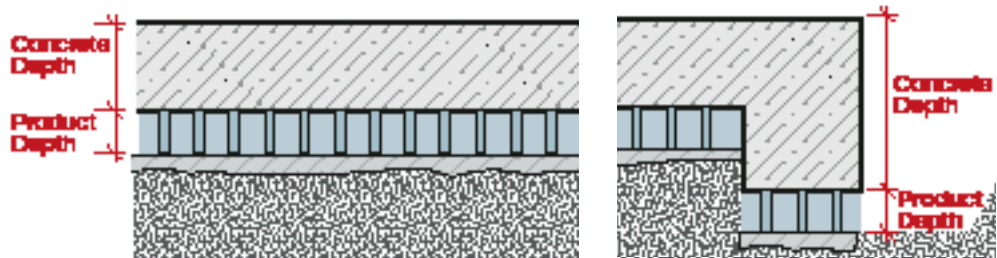


**Beam**



**Pecavoid® for slabs;**  
**Pecavoid® for beams;**

Supplied in 2.4 m x 1.2 m standard sheets  
Supplied in 2.4 m lengths x beam width  
(Min. beam width; 300 mm)





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# Pecavoid® Plus<sup>+</sup>

Reduced depth grades with top  
& bottom boards for minimal  
excavation



## Pecavoid® Plus+; Advanced Ground Heave Solution

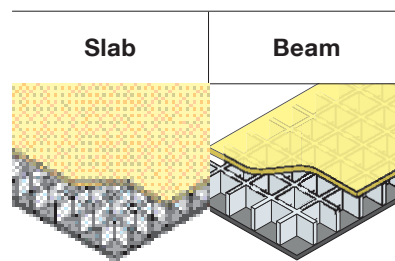


### What does Pecavoid® Plus offer?

Top & bottom board solution:

- increased rigidity
- more robust
- improved reliability

- **More comprehensive BBA-certified range**
- **Reduced depth grades** – minimal excavation & soil removal
- **Top and bottom boards** – increased robustness when handling & installing
- **Provides greater confidence** for Specifiers and Contractors
- **Supported and verified** by our full, in-house testing



Concrete Depth (mm)

100 - 260	08/12
261 - 300	09/13
301 - 340	10/15
341 - 460	13/19

Void Requirement	Product Depth (mm)	
Low	90	85
Medium	160	155
High	225	220



The above certificate applies to Pecavoid® cellular void formers up to 15/22 grade



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# Pecavoid® RD

Reduced depth grades for  
minimal excavation depths



## Pecavoid® Reduced Depth Range

- **Minimal excavation** – reducing time spent on dig-out
- **Reduced removal** of contaminated material for disposal
- **Wide choice of grades** to suit concrete depths from 100mm to 1,140mm
- **Supported and verified** by our full, in-house testing
- **BBA certified** grades

Concrete Depth (mm)			
	Slab	Slab with insulation	Beam
100 - 260		08/12	
261 - 300		09/13	
301 - 340		10/15	
341 - 460		13/19	
461 - 540		15/22	
541 - 660		18/24	
661 - 900		24/32	
900 - 1140		30/40	

Void Requirement	Product Depth (mm)		
	90	130	85
Low			
Medium	160	200	155
High	225	265	220



The above certificate applies to Pecavoid® cellular void formers up to 15/22 grade



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## Pecavoid® C-Range

High load grades - for deep  
concrete suspended foundations



## Pecavoid® for High Loads

- **High load grades** for deep concrete suspended foundations
- **Ground heave resistance** up to and beyond 2m head of concrete
- **Wide choice of grades** to suit concrete depths from 900mm to 1,940mm
- **Large and non-standard grades** verified by our full, in-house testing

Concrete Depth (mm)	Product Depth (mm)		
	Slab	Slab with insulation	Beam
900 - 940		25/35	
941 - 1140		30/40	
1141 - 1340		35/45	
1341 - 1540		40/50	
1541 - 1740		45/55	
1741 - 1940		50/65	
Void Requirement	Product Depth (mm)		
Low	105	150	100
Medium	180	225	175
High	255	300	250

### 1 Choosing the right grade for your concrete depth

When selecting the relevant Pecavoid® grade please note the maximum concrete depth, for each grade of material. For assistance please **call our technical team** or refer to our Pecavoid® online selector tool.

100 mm - 260 mm	08 / 12 [kN/m <sup>2</sup> ]
261 mm - 300 mm	09 / 13 [kN/m <sup>2</sup> ]
301 mm - 340 mm	10 / 15 [kN/m <sup>2</sup> ]
341 mm - 460 mm	13 / 19 [kN/m <sup>2</sup> ]
461 mm - 540 mm	15 / 22 [kN/m <sup>2</sup> ]
541 mm - 660 mm	18 / 24 [kN/m <sup>2</sup> ]
661 mm - 900 mm	24 / 32 [kN/m <sup>2</sup> ]

This table is an example to demonstrate grade selection. See pages 10-15 for the full product range & grade selection.

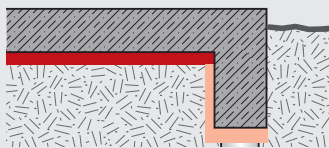
### 2 Check soil plasticity – choosing a soil shrinkage category

Plasticity Index PI (%)	Shrinkage Category	Vertical Movement Clear Void Dim. (mm) ↑	Lateral Movement Clear Void Dim. (mm) ↔
10 - 20 %	Low	50	0
20 - 40 %	Medium	100	25
40 + %	High	150	35

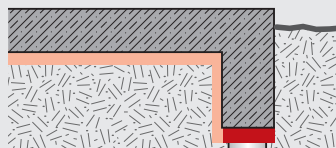
For “very high shrinkage” application please contact our technical team.

### 3 Choose application type

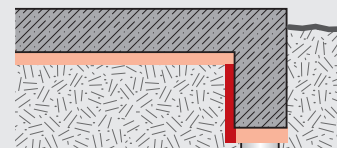
Slab



Beam



Lateral Beam



### 4 Choosing product thickness in case of shrinkage

Slab \*Insulated Beam

Void Requirement		Product Depth		
Low Shrinkage		90 mm	130 mm	85 mm
Medium		160 mm	200 mm	155 mm
High		225 mm	265 mm	220 mm

\* Based on standard insulation



**5 Choose insulation if required**

Product Type (Thermal Conductivity)				
Thickness (mm)	Standard (0.036 W/mK)	Bronze (0.031 W/mK)	Silver (0.030 W/mK)	Gold (0.020 W/mK)
50 (Standard)	1.39	1.61	1.67	2.50
75	2.08	2.42	-	3.75
80	-	-	2.67	4.00
100	2.78	3.23	3.33	5.00
125	3.47	4.03	-	-
130	-	-	4.33	6.50
150	4.17	4.84	5.00	7.50

**6 Calculation of residual uplift**

**Medium Shrinkage, Slab 250 mm deep**

Dead Load = 0.25 m x 25 kN/m<sup>3</sup> = 6.25 kN/m<sup>2</sup>  
 Live load allowance = 1.5 kN/m<sup>2</sup>  
 Total down/safe load = 7.75 kN/m<sup>2</sup>

Select grade 8/12 using the selection tables on pages 10-15  
 (safe load of 8 kN/m<sup>2</sup> and a failure load of 12 kN/m<sup>2</sup>)

Residual uplift  $P_E = (Y_Q \times F_L) - (Y_G \times D_L)$   
 $(1.5^* \times 12 \text{ kN/m}^2) - (0.9^* \times 6.25 \text{ kN/m}^2) = 12.375 \text{ kN/m}^2$

Medium Shrinkage: 100 mm clear void recommended  
 Products Available = Pecavoid Plus Slab160, Pecavoid RD Slab160, Pecavoid RD Insulated Slab200

**High Shrinkage, Ground Beam 500 mm deep**

Dead Load = 0.5 m x 25 kN/m<sup>3</sup> = 12.5 kN/m<sup>2</sup>  
 Live load allowance = 1.5 kN/m<sup>2</sup>  
 Total down/safe load = 14 kN/m<sup>2</sup>

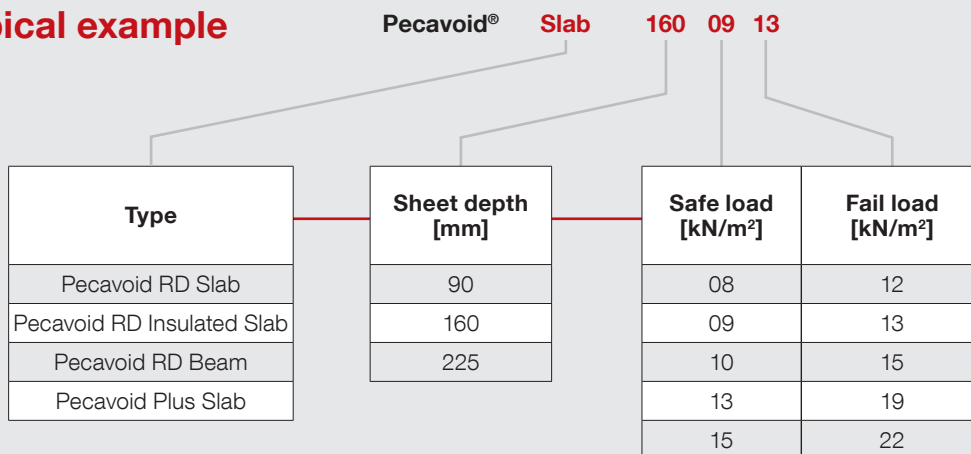
Select grade 15/22 using the selection tables on pages 10-15  
 (safe load of 15 kN/m<sup>2</sup> and a failure load of 22 kN/m<sup>2</sup>)

Residual uplift  $P_E = (Y_Q \times F_L) - (Y_G \times D_L)$   
 $(1.5^* \times 22 \text{ kN/m}^2) - (0.9^* \times 12.5 \text{ kN/m}^2) = 21.75 \text{ kN/m}^2$

High Shrinkage: 150 mm clear void recommended  
 Products Available = RD Beam220

\*where  $Y_Q = 1.5$  and  $Y_G = 0.9$ , the residual uplift should be calculated using the relevant partial safety factors stated in the design code being used.

**7 Typical example**



The above is an example only and does not show the complete range available. Try our online calculation tool - see page 23.

Pecavoid® units 155mm and deeper, are designed to collapse, creating a void for the ground to heave into. Therefore, once the leg matrix collapses, a reduced uplift force will be transferred to the structure (unlike compressive materials or products, that recover and are still able to transfer uplift as any heave occurs). This is particularly important, when considering large open spanning ground slabs as uplift is greatly reduced after collapse occurs. Therefore, a smaller area may be considered when calculating the overall uplift force on the supporting element of the structures.

- Independently tested by BRE (Building Research Establishment)
- Testing simulates real construction environment
- Accepted for use by a wide range of warranty schemes

## Testing & Approval

Testing was designed to simulate the construction process by applying varying loads to Pecavoid® units. Exhaustive testing was undertaken at the BRE and results submitted to the BBA. The tests were carried out in two phases; firstly a load was applied to simulate the application of steel reinforcement and concrete. Secondly an overload was applied, representing ground heave, to induce collapse of the panel – the panel being required to meet and achieve a specified minimum collapse depth.

Pecavoid® is produced in a specific number of grades to suit varying load applications and soil characteristics. Tests were therefore undertaken across a range of Pecavoid® products to confirm their compliance and suitability for the range of situations experienced in a real construction environment.



The above certificate applies to Pecavoid® cellular void formers up to 15/22 grade




Below Rigorous testing at the BRE; Inset Overload induced collapse to meet standards



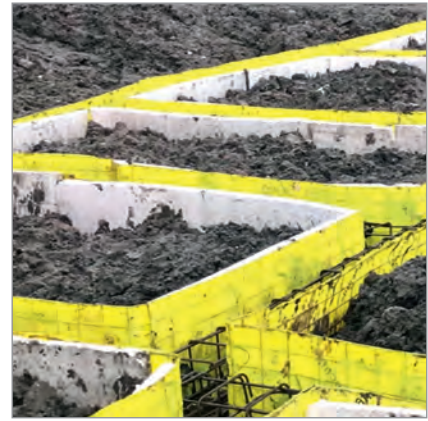
## Clayfill Side Protection Board

Side protection board is used to prevent problems in foundations where the soil has a high clay content and is liable to heave. The product is designed to reduce lateral pressure on ground beams and on the side of trench foundations. It is a low density coloured EPS for the purpose of easy identification.

Clayfill side protection board, does not compress significantly until loads exceed 20 kN/m<sup>2</sup>. To produce 50% compression a load of 40 kN/m<sup>2</sup> is needed. It is not recommended for use under ground floor slabs or pile caps.

Shrinkage potential	Predicted lateral movement (Clear Void)	Clayfill thickness required for void
 Low	zero	zero
 Medium	25 mm	50 mm
 High*	35 mm	75 mm

\*Please contact us if the shrinkage potential is more than high.  
Sheet size: 1.2 m x custom size – cut to required thickness.



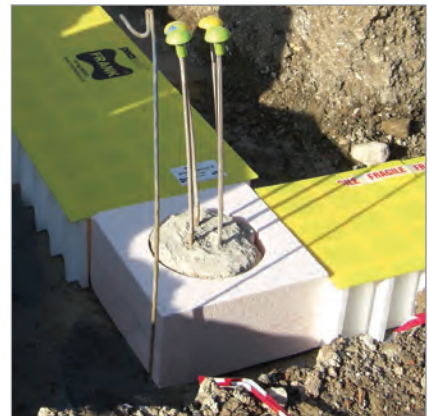
## Pile Collars

Pile collars are an effective solution to maintain ground heave protection around complex pile areas.

We recommend the use of pile collars, together with Pecavoid® and side protection board, to maintain a clear void and prevent the effects of clay heave.

NHBC inspectors also report that gaps can often be found where the square edges of the void former meet the circular pile. Unless the gap is properly filled with void former, heave problems will occur.

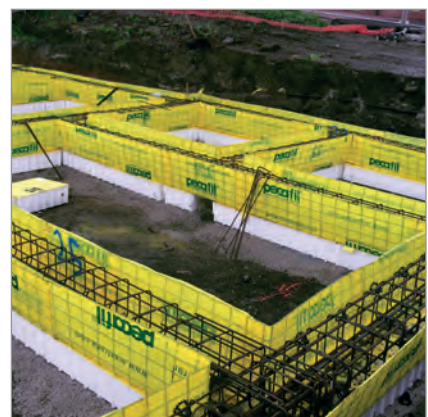
Pile collars of suitable size, made from low density expanded polystyrene, can be provided to eliminate grout loss at pile positions.

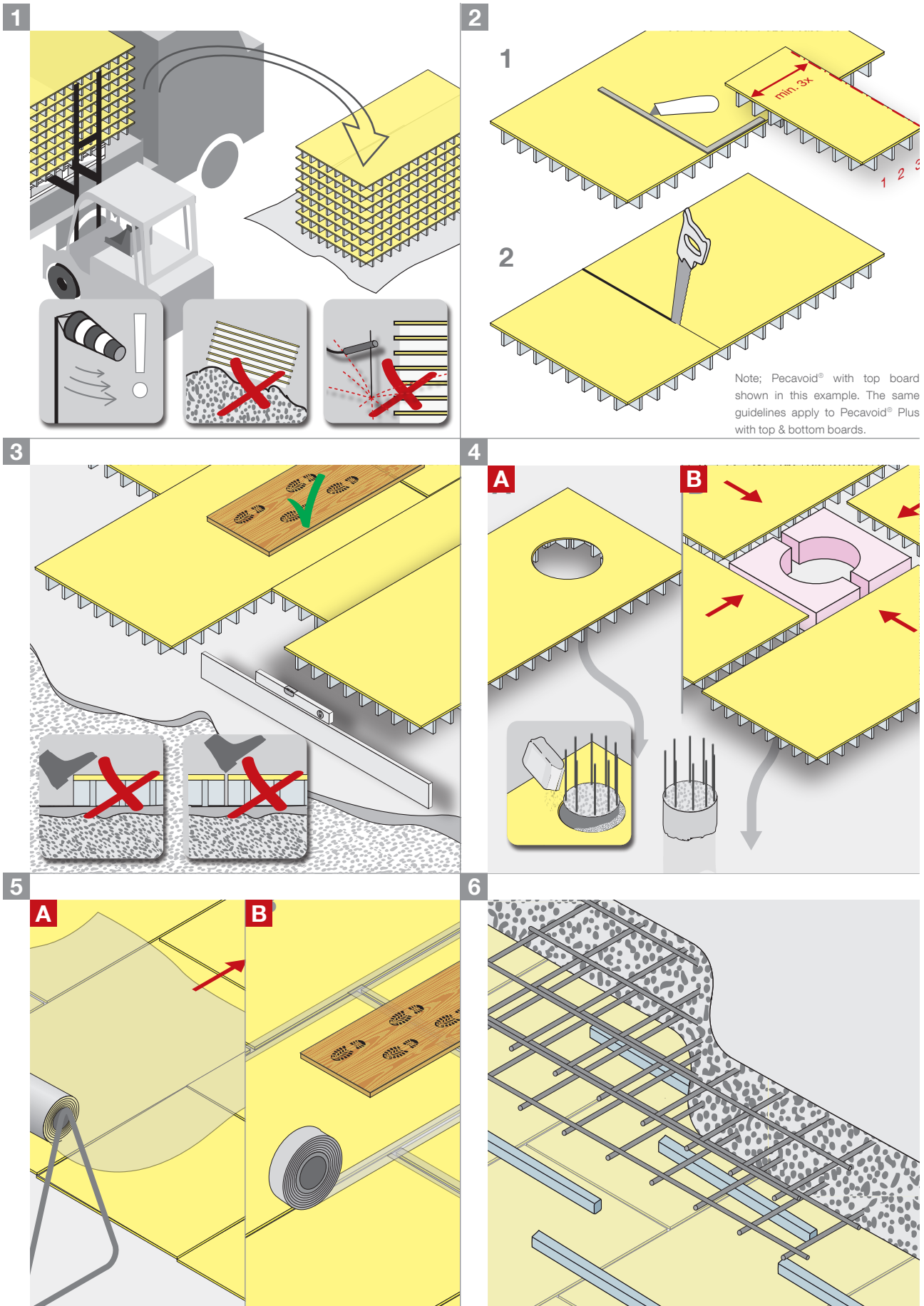


## Pecafil® permanent formwork

Pecafil® is the **original** permanent formwork solution which provides a time-saving and cost-effective method for constructing in-situ reinforced concrete foundations.

Pecafil® is widely used for the construction of ground beams, box-out shutters, floor-edge forms, pile caps and bases. It can be used as a separation material between the concrete face and steel sheet piles or contiguous concrete piles, and can be adapted for use as weather, dust and privacy protection screens.





This installation guideline is exclusively regarded as a recommendation and does not replace any expert knowledge required for installation. It may be necessary to alter these recommendations. The currently updated and valid version is available at [www.maxfrank.com](http://www.maxfrank.com). In addition, MAX FRANK's general Terms and Conditions shall apply.

### Problem: Slag heave

Project: **Anaerobic Digestion Plant**

Location: **Middlesbrough**

Product: **Pecavoid® type CL105 15/22**

Deposits of blast furnace slag on site, up to 4 m deep, posed a risk of ground heave. A void needed to be created underneath the piled slab tank bases to accommodate the upwards expansion.

Pecavoid® was selected to combat slag heave and installed beneath the 350 mm thick piled slab, creating the required 50 mm clear void.



### Problem: London clay – vegetation removal and overburden recovery

Project: **Chelsea Barracks – Residential & Commercial Development**

Location: **London**

Product: **Pecavoid® types RDS, RD+, CL,  
Shearail® punching shear reinforcement**

Reduced depth Pecavoid® resulted in less dig and cart-away on site. Pecavoid® type RD+ provided insulation. MAX FRANK's reputation and lead time was part of the reason chosen by the main contractor. Our FORS compliance also meant reliable delivery to site.



### Problem: Ground water pressure

Project: **Heathrow Airport T2B**

Location: **London**

Product: **Pecavoid® type CB250 25/35 with drainage holes,  
Pecafil® VR6 and VR8 flat strips, MAX FRANK bar spacers**

Specially manufactured Pecavoid® for this scheme incorporated drainage holes within the Pecavoid® units to relieve water pressure and allow drainage between cells. The use of Pecafil® on this project avoided the need for heavy traditional formwork and enabled a quick and simple installation process. MAX FRANK fibre concrete bar spacers were also used to ensure that the correct cover was maintained at all times.



### Problem: Integrated formwork & BBA approved ground heave solution required

Project: **Private house development**

Location: **Preston, Lancashire**

Product: **Pecavoid® type RDB155 13/19  
Pecafil® flat strips**

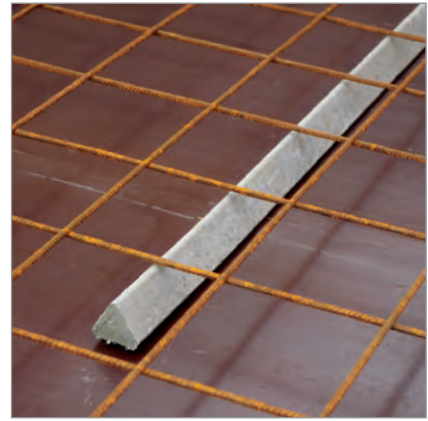
MAX FRANK's Pecafil® and Pecavoid® were ideal. Reduced depth Pecavoid® was suitable for the application, resulting in less dig & cart away onsite. The Pecafil® was later stripped from the concrete beam and re-used.



## Fibre concrete spacers

MAX FRANK's range of extruded fibre-reinforced concrete spacers ensures that the specified concrete cover to the reinforcement for structures and structural elements is achieved, both before and during concreting.

MAX FRANK spacers help to guarantee the durability of all structures.



## Stremaform® stay-in-place jointing formwork

Stremaform® self-supporting formwork speeds up construction and ultimately enables substantial cost savings.

Stremaform® applications include; raft foundations, deep slab construction, transfer slabs, crane bases, large ground beams, pile caps and core foundations – poured in more than one pour.

Stremaform® can be prefabricated to suit your project needs.



## Shearail® punching shear reinforcement

Shearail® is a certified prefabricated punching shear reinforcement system for flat, piled and post-tensioned slabs. It is designed to increase construction speed, improve build quality and reduce dependency on skilled labour – significantly reducing on-site costs.

Shearail® is the **only** proven punching shear solution with both CARES Technical Approval and BBA Certification.

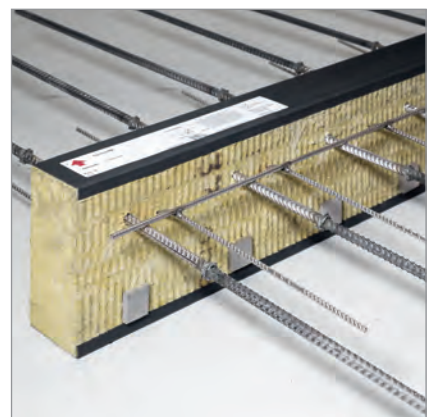
Design software package available to download.



## Egcobox® thermal break solutions

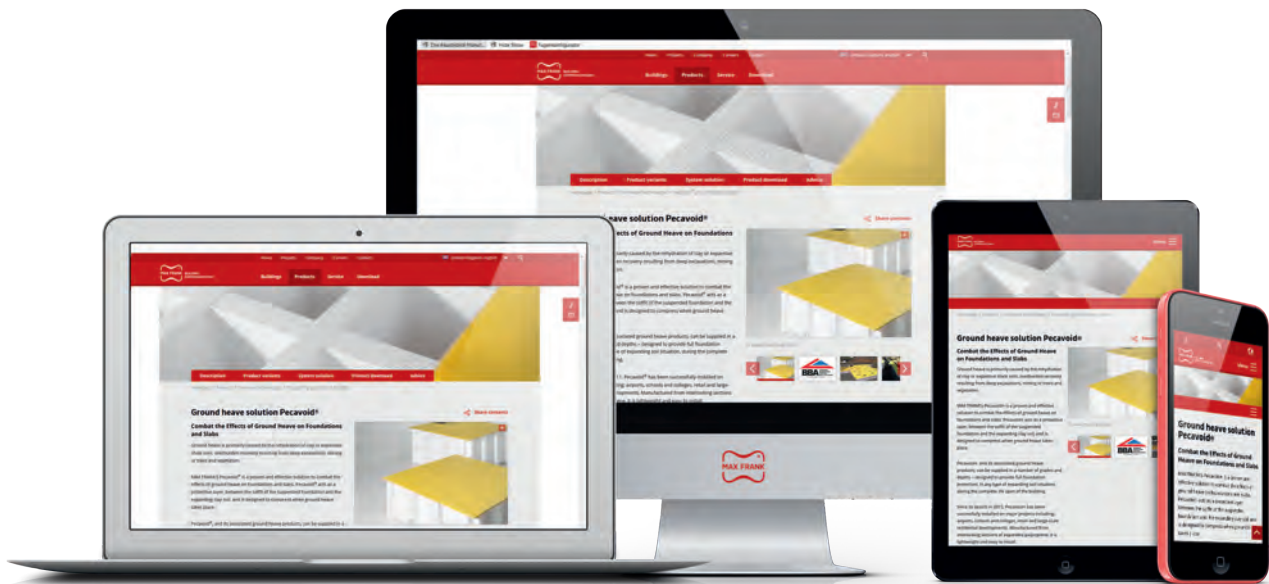
Minimise thermal bridging by creating a thermal break between an external component and an internal component, reducing condensation and mould formation. Egcobox® BBA approved thermal break connectors, with mineral wool insulation, are proven to fire rating REI 120 and conform to the amended Building Regulations 7(2) for combustible products for England.

Design software package available to download.



# Speedy Pecavoid® Calculation!

MAX FRANK’s time-saving calculation tool has been created, tested and developed with YOU in mind. The online calculator enables engineers and estimators to select the appropriate ground heave solution, quickly and efficiently, in a few simple steps.



## PECAVOID® CALCULATION IN A FEW SIMPLE STEPS

### 1. Project details

Enter the scheme name & location, number of project sections, heave risk & foundation design.

### 2. Design summary

Record details of the foundation requirements for each project phase; select the structural element, concrete depth, heave potential/void requirement & insulation options.

### 3. Specification

Your tailored Pecavoid calculation is produced.  
[www.maxfrank.com/pecavoid-spec](http://www.maxfrank.com/pecavoid-spec)



## CPD SEMINAR: GROUND HEAVE “BEST PRACTICE”

MAX FRANK piled foundations, rafts and slabs can be affected by ground heave caused by volume changes in swelling clays due to clay type and moisture variation. This presentation examines the causes and effects of ground heave and the ways in which the problem can be avoided through the correct use of ground heave products. The presentation usually lasts 45 minutes with a question and answer session at the end. MAX FRANK will be happy to cover the cost of refreshments.

Please contact [cpd@maxfrank.co.uk](mailto:cpd@maxfrank.co.uk)



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