premier guarantee®

Technical Update: Protecting below-ground environments on sloping sites

Protecting below ground environments on sloping sites from the ingress of groundwater

Introduction

This technical document provides an understanding of how ground water flows and acts on below ground structures across sloping sites. It also considers what to look for in the design and application of an effective waterproofing system to prevent the ingress of water.

Building on escarpments can provide a wide variety of domestic design like a three-storey bungalow. The front elevation appears as a single-storey dwelling but the rear turns into an amazing three-storey façade. However building on a slightly sloping site appears to be a lot more challenging to both designers and builders.

This article is not about aesthetics' or basement construction but the consideration required for the protection of building elements and the habitable environment of construction below ground level from the presence of ground water across a sloping site.

Water and pressure

For a moment consider the experiment we all probably experienced in the science class at school.

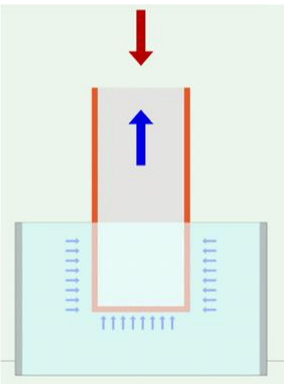

Fig 1a

Here we have a clear container being pushed into a reservoir of water with the water surface level with the top. As the container is pushed below the surface the following is experienced.

1. Water is displaced from the reservoir
2. Pressure or resistance is felt increasing the deeper it is pushed. (Fig1a)

The clear container being pushed below the surface remains dry internally.

Should a hole be drilled into the container and pushed below the water surface. Water will seep into the container. If the container is left at a constant depth over time, the water in the clear container will fill to match the level of the water in the reservoir until a constant level of water is established. (Fig 1b)

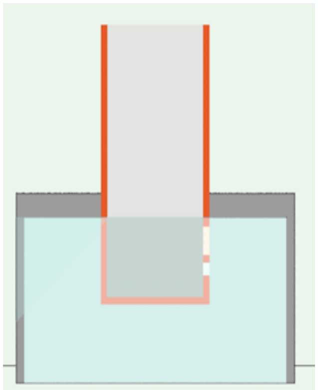

Fig 1b

The two principles determined is that

(i) Water will exert a pressure in all directions increasing with depth
(ii) Water will always find its own level.

When a building is placed into ground where groundwater is present or where water filters through and saturates the ground, the guiding principles above are similar. Masonry walls and floor constructions will provide structural integrity and create a barrier between the ground and the living environment. The problem is that masonry and floors are not good barriers for preventing the ingress of groundwater into a building.

Building protection

Consider the following illustrated example of a building on a sloping site. If ground water was allowed to enter at the highest slab level. What level of water could potentially be in the lower building if no waterproofing was provided?

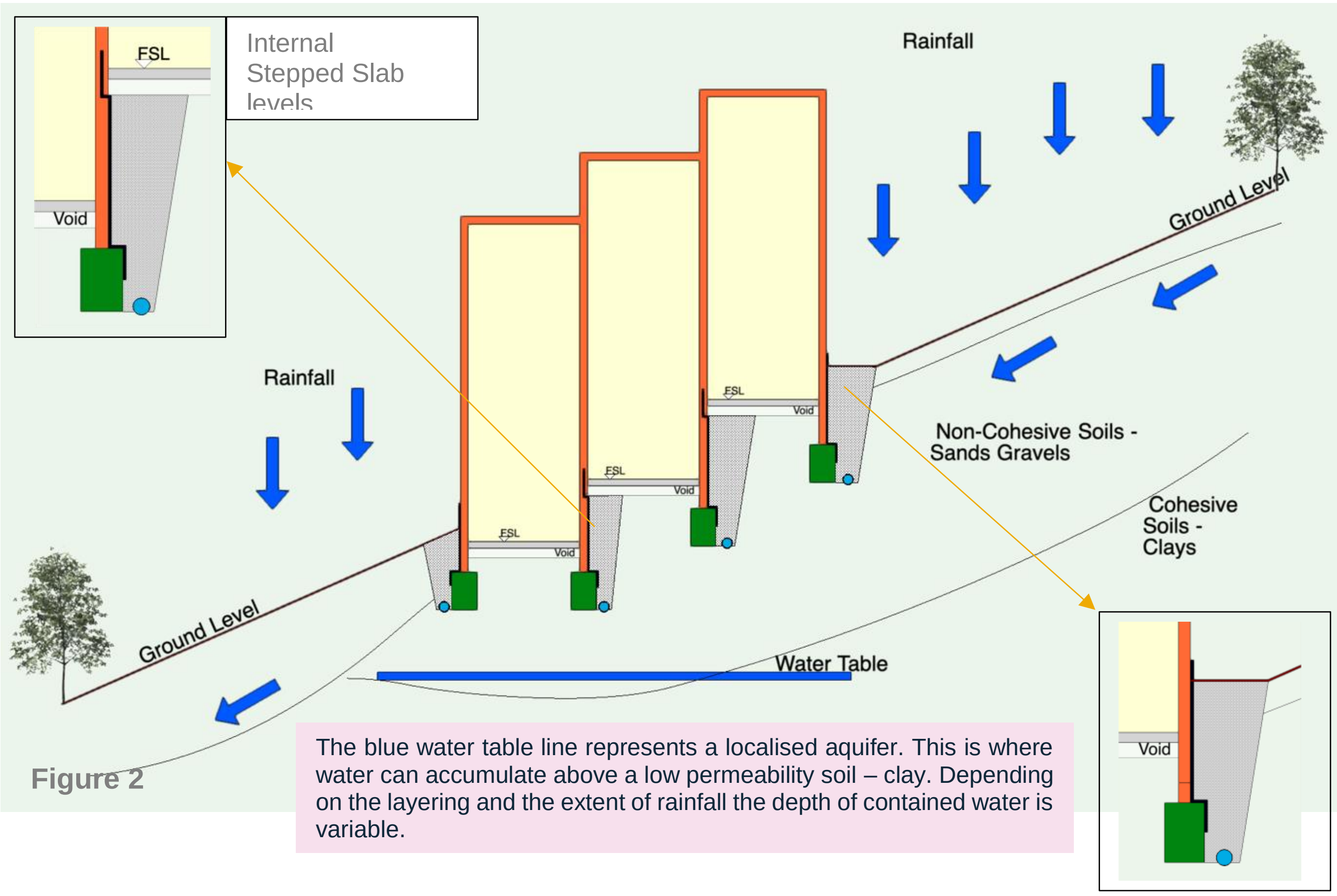

Figure 2

The blue water table line represents a localised aquifer. This is where water can accumulate above a low permeability soil – clay. Depending on the layering and the extent of rainfall the depth of contained water is variable.

Ground floor slabs and environments must be protected from the ingress of groundwater and damp where they are located below the external ground level. Two methods are available which can effectively protect ground slab and environment when located below the external ground level.

First is to minimise the effects of hydrostatic pressure or head of water around the building footprint. Water meeting a wall builds pressure, increasing with depth. However, when water is allowed to flow through a granular medium to a land drain correctly positioned at a lower level, the horizontal pressure on the wall is alleviated.

Secondly, water has no boundaries it will follow a natural flow path in the ground, Therefore water and moisture will always be present as it takes time for surface water to percolate through the ground. It must be assumed that water will be present on walls below ground across a sloping site. Masonry walls provide only a little resistance to ground water and therefore all walls below ground on a sloping site will require waterproofing in the form of a barrier protection.

Figure 2 above shows illustratively the natural flow path of water. Water in the form of rain, falls to the ground and then percolates through the ground layers naturally migrating along the slope pending on soil layering to a point where it meets an impervious layer such as a clay. Groundwater is often apparent above these clay layers and can accumulate raising localised water levels considerably. The effect of placing buildings on a natural slope will create a dam effect to the natural flow of water in the ground and hence protection to the built environment becomes necessary.

Protection from groundwater - external walls

This can be successfully achieved by placing a maintainable land drain at foundation level and backfilled with clean graded stone as detailed in Section 2 of the Premier Guarantee Technical Manual (v14). This is not a waterproofing method, the purpose of the maintainable land drain is to reduce the hydrostatic head. Moisture and water should always be considered as being present in the ground.

Where a maintainable drain is adopted, a suitable design and material specification of a waterproofing system becomes essential. As water pressure is relieved, a waterproofing system must be applied to the external vertical surface. It should be continuous and linked to the damp proof course (DPC) 150mm above the finished ground level. In addition the waterproofing layer when applied externally will need to be protected from damage by any subsequent backfilling. Depending on the known hydrology and site topography it may also be necessary to waterproof the slab and make it continues with the vertical element.

A CSSW certificated waterproofing design specialist must be engaged to ensure that the detailing of the waterproofing is compliant with BS 8102 for the below ground construction and the building environment. In addition the waterproofing designer along with the architect must give consideration in the thermal detailing of the walls as areas below ground will be different to the wall above the ground. Detailing will also need to be considered for suspended floors where ventilation is required to the void below the floor.

Hydrostatic pressure to the wall on the down slope, could be argued, is minimal negating the use of a land drain. This could be considered as the water pressure is controlled at the upper levels. However depending on the foundations relative position with the upper levels it may be necessary to introduce a further maintainable land drain.

Protection from groundwater - internally stepped slabs

A maintainable land drain at foundation level and backfilled with clean graded stone may be deemed necessary dependent on the slope. Figure 2 suggests that water could still be present on the internal walls at slab level necessitating the reduction of hydrostatic pressure. Again, a suitably designed barrier protection must be applied to the wall facing the upper slope as most membrane barriers work effectively when positive pressure is applied. Waterproofing must be continuous with the DPC and extend above the slab level. It will be noted that the waterproofing layer is not continuous through the floor slab. This is because most waterproofing membranes will deform due to excessive and permanent stresses and will therefore not act as a DPC (creep or cold flow). Depending on the foundation, wall, and slab construction careful consideration is required by the waterproofing specialist to ensure that all the potential paths for water to penetrate the building environment are blocked.

Consideration for cold bridging and sub floor ventilation also need to be considered in the design.

Technical Update: Protecting below-ground environments on sloping sites

The illustration used is for a larger site on a relatively steep slope but it does emphasise what areas need to be considered in waterproofing of slabs and environments located below ground level. Most construction sites however will have slopes with a much lower gradient, but if the two design guidances are considered, namely:

a. reducing the hydrostatic pressure with a correctly position maintainable land drain, and
b. providing a continuous waterproof barrier to the porous walls and floors forming the structure,

then successful protection will be provided.

Further design considerations are given in the Premier Guarantee Technical Manual (v14):

2.1.4 General requirements: Sub-Surface drainage
2.2.1 Waterproofing Systems: Type A – Barrier protection
4.4.1 General Requirements for concrete floors: Stepped floors and damp proofing

The design for any below ground structures must meet the requirements of British Standard BS 8102:2009 *Code of Practice for protection of below ground structures against water from the ground*. Clause 4.2 states that a waterproofing specialist should be included as part of the design team.

Limitations

The above guidance is for structures where the below ground structure, the slab, and the environment is not greater than 600mm below the DPC.

It is recommended that a CSSW waterproofing designer who will accept responsibility for the design solution be appointed in all cases.

Every care was taken to ensure the information in this article was correct at the time of publication. Guidance provided does not replace the reader's professional judgement and any construction project should comply with the relevant Building Regulations or applicable technical standards. For the most up to date Premier Guarantee technical guidance please refer to your Risk Management Surveyor and the latest version of the Premier Guarantee technical manual.