ICF structural waterproofing

***Paul Green** of **Triton Systems** discusses structural waterproofing of insulated concrete formwork (ICF) structures below ground level with concrete infill and slabs.*

The first patent for an insulated permanent formwork for concrete was registered in the early 1940s in Switzerland; the system used recycled waste wood and cement as the insulating material. The first polystyrene ICF was developed in the late 1960s after the original patent ran out and following the development of modern foam plastics.

Today, the ICF units usually simply lock together (in a similar way to a child's Lego bricks), to create a suitable form for the structural walls of a building. As with in-situ formed concrete walls and floors, reinforcing steel bars are usually placed inside the forms before concrete is poured to give the predominantly concrete structure flexural strength and to reduce cracking. However, unlike other concrete formwork, the ICF forms have to be filled in a more controlled manner, to aid in managing the weight and pressure brought to bear on the polystyrene blocks. The actual 'lift' of each concrete pour to the ICF walls will vary from manufacturer to manufacturer; in general, they would be in the region of 500–1000mm.

When placing concrete within the ICF units, there is a potential for damage to occur, both from pouring heavy, viscous concrete into a relatively fragile structure and when vibrating and compacting the concrete sufficiently. Careful placing and compaction of the concrete is required to minimise damage, along with adequate propping of the ICF structure prior to pouring the concrete. It is sometimes difficult to determine if this has been done well enough to release all the trapped air from the mix and to avoid honeycombing within the concrete due to poor compaction/vibration. One way of addressing this problem would be to use self-compacting concrete – although there would be cost implications.

In addition to standard prespecification considerations, eg, water:cement ratio, cement type, strength, and the requirement for watertight concrete or other additives, it is also advisable to discuss the size of aggregate within the mix design with the ICF manufacturer and concrete supplier, to ensure an appropriate mix for the structural requirements, waterproofing and the void spacing within the ICF. Specifying an appropriate level of consistence for the concrete is also important and guidance should be sought from the manufacturer. Generally, slump class S3 is specified but S4 would offer greater fluidity of the poured/pumped concrete within the ICF unit.

Below ground level

As with any structure below ground level, irrespective of the required grades of watertightness (Grades 1, 2 or 3 as defined in BS 8102:2009[(1)]) and the structure's intended use, it is critical to ensure that all types of construction and joints are well protected against the ingress of groundwater.

In this regard hydrophilic waterbars can be installed at wall–floor junctions and around penetrations, and neoprene rubber strips can be used at expansion joints. Consideration must also be given to the potential construction or pour joints between each concrete wall lift. The concrete is generally poured continuously within the wall forms, but interruption in supply, or larger wall runs, can lead to 'cold' joints forming. It is therefore also advisable to discuss the preferred criteria for pour lifts and lengths with the ICF manufacturer, and appropriately detailing within the waterproofing specification.

A simple and effective way of overcoming this potentially tricky jointing detail can be the application of a cement-based crystalline waterproofing treatment, either by dry sprinkle or slurry coating the exposed face of each lift. The use of active cement-based slurries allows the insoluble crystalline growths to form in both previous and subsequent pours. Crystalline active slurries are acknowledged within BS 8102 as appropriate measures for waterproofing construction joints within concrete. The use of other water-resistant admixtures, which react with and lock in excess free lime to the mix, is beneficial where the secondary waterproofing to the ICF basement is an internal cavity drain system.

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Insurance companies such as the NHBC, who will be understandably anxious to reduce risks of system failure, often look upon the use of both integral and dry sprinkle admixtures favourably. In Chapter 5.4 of the NHBC Standard[(2)], it is further stipulated that any waterproofing design should be undertaken by suitably qualified persons (the Certificated Surveyor in Structural Waterproofing qualification is suggested

Figure 1: ICF concrete pour at project.

Figure 2: Poorly compacted concrete.

Figure 4: Spray-applied vapour membrane (see Figure 6).

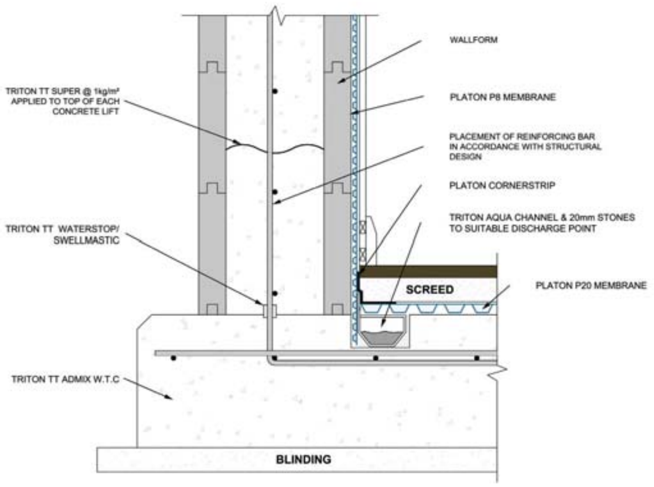

Figure 5: Waterproofing options – Grade 3 high risk.

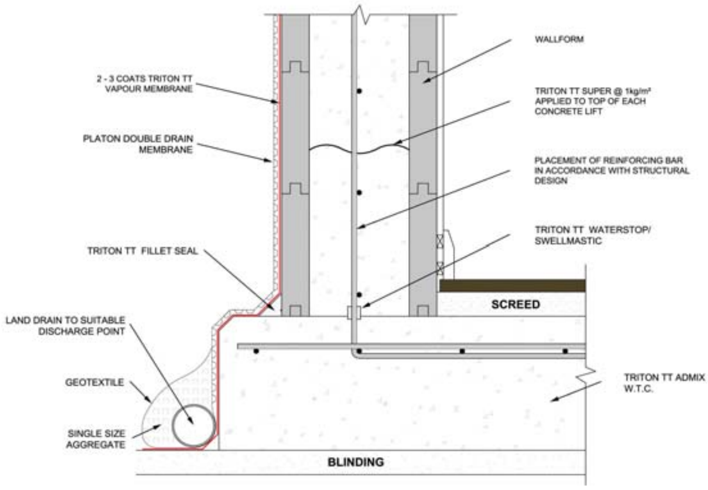

Figure 6: Waterproofing options – Grade 3 low risk/sloping site/free-draining soil.

as an example) and that person should be appointed early in the design phase.

When the soil investigation report indicates the construction is being made on high-risk strata such as clay or areas of temporary perched water tables, risk of water ingress can be further reduced by the installation of an external land drain, properly located, maintainable and discharging to a reliable outlet or sump and pump arrangement.

If the risk assessment required under BS 8102 indicates that the consequences of failure for any chosen system are too high, additional measures can be taken. These can be sheet liquid membranes applied over the concrete blinding and beneath the slab, and subsequently continued up and around a dual-applied external waterproofing system. The membranes can be either of the flexible sheet variety, fully bonded adhesive types or liquid applied. Sheet/elastomeric liquid-applied types may be considered the safer option with ICF units, but it is important to determine that any type used is compatible with the ICF structure.

Compatibility of all waterproofing elements will also be assured by sourcing from a single point of supply – a further recommendation within BS 8102. As mentioned above, this Standard requires the waterproofing designer to carry out a risk assessment taking into account the site conditions, form of construction and usage of the below-ground space. Often this will lead to the recommendation to use two forms of waterproofing, something required by NHBC for example.

Figures 5 and 6 provide examples of some BS 8102-compliant ICF waterproofing specification options mentioned above, but they are not an exhaustive selection. Figure 7 depicts an external waterproofing system in progress.

Overall, ICF brings many benefits; the formwork process is fast and doesn't require any specialist skills. Even self-build teams can usually get training from the main ICF manufacturers on the installation of these systems. Curves and complicated shapes are not a problem, as good manufacturers can tailor all accordingly. ■

References:

1. BRITISH STANDARDS INSTITUTION, BS 8102. *Code of practice for protection of below ground structures against water from the ground*. BSI, London, 2009.
2. NATIONAL HOUSE BUILDING COUNCIL. NHBC Standards 2016, Chapter 5.4. *Waterproofing of basements and other below ground structures*. NHBC, Milton Keynes, October 2014.

Figure 7: External waterproofing system.