SUSTAINABLE foundations

When building from the ground up it's more important than ever to be green. ROGER HUNT lays the foundations for sustainable building.

ABOVE Van Elle Smartfoot System: the Smartfoot beams being lowered into position

Foundations potentially use significant resources. According to Sustainability in Foundations, a review by the BRE Trust, the trench fill foundations for a typical semi-detached house comprise some 18m3 of concrete, or the equivalent of around 3,000kg of embodied carbon dioxide (CO2). In addition, excavated waste may need to be taken away. This need not be the case, new systems and materials are enabling these hidden components in the construction of homes to be as green as the building elements above ground.

Cost considerations, ease of construction and a tendency to stick to 'traditional' techniques often dictates foundation choice. One of the problems is that there is no one fits all solution as every site presents different soil conditions while a variety of other local factors must be considered such as trees, groundwater, contamination and construction noise and vibration.

Another important reason that foundations are not always considered in sustainability terms is that they tend to be left to a groundworks contractor who might not have a particular interest in sustainability. The contractor may also be left out of the loop with little or no contact with the architect or other key team members who, in other respects, are working towards creating a sustainable building.

At MDA, a company providing project management and quantity surveying services to residential and commercial construction projects, residential director Keith Bowler brings some perspective to the issue. "At present, sustainable forms of foundation construction are seen to be more expensive than traditional cast in-situ foundations, but they are faster to construct. This is not always advantageous to volume housebuilders as they tend to build in phases over a period of time, so the speed of construction is not always a consideration."

Nigel Chandler, commercial manager at Coinford, a company specialising in groundwork construction and design and build, comments: "The design of foundations is mostly put in place by the client's structural engineer. As contractors, one way we can influence the design of foundations and make them more sustainable is by suggesting and installing 'post tensioning'. This can reduce the quantity of concrete and reinforcement needed in the super-structures, therefore reducing its weight and subsequently the size of foundations required."

The BRE Trust report is clear that the most cost-effective solution may not necessarily be the one with the least environmental impact. Even so, Tim Reynolds, senior consultant BRE and co-author of Sustainability in Foundations, emphasises that: "There are some very efficient systems out there at the moment and ground floors have changed markedly over recent years with the more engineered solutions."

Reynolds suggests that piling is generally a better technical solution than deep trench foundations. "Pilling is very risk free and a safer solution in that you don't have people working and constructing in deep trenches. It is also a better sustainability solution because it uses much less concrete, although the concrete is generally a higher strength and there is some reinforcement in it."

One specialist foundation engineering company is Roger Bullivant. It offers a range of products and services and John Patch, its director of marketing and sales, has noticed that packages combining foundations with a highly insulated ground floor have become far more interesting to customers.

"We're finding that with the cost of taking waste material off site, and indeed the cost of concrete and raw materials in making concrete, that these systems are now cost effective even against ordinary strip foundations."

BELOW Roger Bullivant: Continuous flight auger (CFA) piling in progress. Concrete is pumped under pressure down the hollow stem as the auger is withdrawn

BOTTOM LEFT Roger Bullivant's SystemFirst is installed on site

Roger Bullivant's SystemFirst is a modular foundation and fully insulated flooring system which the company claims will support any low-rise building in all ground conditions. SystemFirst requires no trench excavation and components are manufactured off-site and installed on site with a significant time saving and reduction in concrete use compared to traditional foundations. Despite this, it offers enough material to create thermal mass.

Van Elle's Smartfoot is another modular foundation system. Depending on ground conditions, it is installed with or without piles and uses concrete groundbeams that are cast offsite and then craned into position and tensioned together to form an entire foundation.

"It is completely manufactured off site so there is no waste involved," says Vic Handley, a director of, Van Elle. "What is delivered to site is very quick to install and requires less excavation, plant and

LEFT Van Elle Smartfoot System: the post tensioning operation in progress

RIGHT Roger Bullivant's SystemFirst is installed on site. The polystyrene insulation for the floor fits into the galvanised steel frame

BELOW Precast concrete piles being driven using Roger Bullivant's quiet hammers

labour for its installation and it significantly reduces the time and waste on site. A significant benefit is that, when a building has reached the end of its life, these foundations leave very little scarring on the site and can be reused elsewhere."

Another system – Housedeck – is offered by Abbey Pynford. This is a concrete raft system stabilised by small diameter bored or augured piles and has the advantage of eliminating costly excavations and reducing foundation installation times by up to 50 per cent.

"One of the advantages of Housedeck compared with traditional pile-and-beam options is that pile positioning is not critical and it is therefore possible to pile around existing obstacles such as drains, services or tree roots," says Jenny Howard, business development manager.

Abbey Pynford has recently conducted studies making a direct comparison between the embodied energy of Housedeck and traditional pile-and-beam foundations which reveal that the system can reduce the carbon footprint of foundations by at least a third whilst providing cost savings.

> "There are very important practical reasons why certain foundations systems are used on certain sites"

At the BRE, Tim Reynolds is keen to emphasise the opportunities for using recycled or reclaimed steel for piling and cement replacements like pulverised fuel ash (PFA) and ground granulated blastfurnace slag (GGBS). He points to the fact that GGBS can reduce the carbon footprint by about 50 per cent but each solution needs to be considered on a case-by-case basis.

"There are very important practical reasons why certain foundations systems are used on certain sites and there are constraints on the materials so it's about understanding how well they work," says Reynolds. "It is important to have a process of better site investigation so that the ground properties can be utilised better.

For housebuilders, the 'best practice approach' section of the Sustainability in Foundations review is particularly useful. It highlights everything from the very simple concepts such as "using better accuracy in setting out to minimise the size of ▶

ABOVE Roger Bullivant's SystemFirst galvanised sections installed on piled supports

TOP RIGHT Precast concrete house foundations beams being installed onto precast piles and caps by Roger Bullivant

BELOW SystemFirst is installed on site

BOTTOM A concrete raft foundation by Abbey Pynford 'floats' above the ground

foundations" to "using foundations as part of energy storage and productions systems".

The latter is an area embraced by Roger Bullivant. "We are often asked to incorporate the underfloor heating pipes in the slab because, with SystemFirst, it is a finished slab rather than just being a subfloor and we design, supply and install," explains John Patch.

Roger Bullivant is among the companies incorporating ground source heat pump technology into the piles themselves. "The big thing is there must be early involvement by us because you can't retrofit this stuff. We still have a long way to go in terms of people thinking of piled foundations and engineered foundations as the norm and then being able to get their minds round putting geothermal loops in the piles," says Patch.

Among those to have had direct experience of incorporating ground source heat pump technology into piles is Coinford's Nigel Chandler. "To put the pipes in and fix them to the rebar is another operation and a lot more care is needed because you have got damageable pipes so it took longer but only at the outset. Once we were over the learning curve then obviously it just becomes part of the operations."

The use of geothermal piles for low-rise housing is discussed in 'Efficient design of piled foundations for low-rise housing', an NHBC Foundation design guide. The publication also provides an overview of the environmental impact of foundation solutions ranging from contamination, waste, vibration, noise and air quality to embodied carbon in foundations.

Performance is another part of sustainability. Foundations which fail are not sustainable and ultimately more resources will be used in correcting problems. The NHBC guide suggests that instances where efficiency could have been improved include situations where foundations have not met the design requirements, the type of foundation does not provide the best solution and where foundations have performed adequately, but have been 'overdesigned'.

Looking to the future, Van Elle's Vic Handley sees a need to consider the broader picture. "If we are going to look at things outside the normal concrete foundations it needs everybody to get together to be able to look at those types of innovations and take them forward. We tend to get stuck in a time warp so need to look at other measures. We've looked at recycled polycarbonates and plastics in the past, they worked but they were quite expensive." sh

FURTHER READING

BRE Information Paper: Sustainability in foundations www.brebookshop.com
NHBC Foundation design guide: Efficient design of piled foundations for low-rise housing www.nhbcfoundation.org

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