White paper: Recycled waste and the UK precast concrete industry

Elite Precast Concrete

Contents:

Background:

What is concrete?

For every person on Earth, three tonnes of concrete are used every year. This makes it one of the most consumed materials in the world, second only to water[1]. Concrete is comprised of three elements – cement, water and aggregates – with the first two forming a paste which hardens and binds the aggregates together. The strength of the resulting concrete can be measured using the water/concrete ratio. Multiple materials can be defined as aggregates, and they are classified in numerous ways: *primary* aggregates are materials which are being used for the first time and have been directly mined or quarried, *secondary* aggregates are by-products of other processes which have never been used before, and *recycled* aggregates are materials which are being reused, for example construction or demolition waste.

Key uses:

Given its strength and durability, concrete has become the go-to material for the construction industry and has multiple uses across many sectors. Concrete is found almost everywhere: from buildings to roads to water storage and transportation, from large-scale construction such as dams and bridges to smaller products like kerbs and drains. It can be used as the main material within construction or for specific purposes such as water, fire or sound proofing.

Pre-cast concrete and interlocking blocks:

The pliable nature of unset concrete means it can be moulded into virtually any shape required, this process either takes place on site or concrete can be 'pre-cast', meaning it is shaped and set elsewhere and then transported to the place where it will be used. A subsection of the pre-cast concrete sector is the manufacturing of interlocking concrete blocks.

These are high-strength concrete casts designed to be used in a variety of projects including block wall flood defence, material storage bays, blast walls, retaining walls, kentledge, fire break walls or coastal erosion prevention. They can also be used for temporary works such as creating barriers between open rail lines and those being replaced.

Blocks use high strength concrete to enable maximum durability and very often have a lifetime guarantee. But to ensure this is possible, all material used within them must be of the highest quality from a known source.

The importance of quality:

Put simply, concrete is used as a construction material (twice as much as all other building materials combined[1]) so must be durable enough to withstand pressures such as weather, water and human-usage, depending on the specific application. The production of sub-standard concrete not only has a cost implication for the customer if the materials have to be replaced within a shorter time frame than would normally be expected, but depending where the concrete has been used, there would also be a very real risk to human life should the poor-quality result in crumbling or collapse.

Given the ever-increasing awareness of the environmental impact of construction and the desire to preserve the world's resources, there is also an onus on manufacturers to ensure their products can be recycled where possible when they reach the stage where they are no longer usable in their current form, known as end of life.

Recycling:

Use of recycled aggregates:

A focus on recycling across a broad spectrum of industries in recent years has naturally led to the question of what concrete manufacturers are currently doing to ensure the re-use of aggregates where possible, and what more they could be doing in the future. There is a pressure upon all businesses to look at increasing sustainability through the introduction of a higher proportion of recycled aggregates.

Currently around 200 million tonnes of aggregates are used across the UK every year as raw construction materials, of those around 57 million tonnes (or 28 per cent) derives from recycled or secondary sources[2].

The Mineral Products Association reports a 'public will to reduce the use of primary aggregates in construction' by replacing them with recycled material made from crushing inert construction and demolition waste[3].

With such a large amount of aggregates needed within the construction sector each year, it's simply not viable to continue using solely primary materials to meet that need. The cost of producing concrete from recycled aggregates is often lower than sourcing primary aggregates, a saving which can be passed on to the customer. Reducing the amount of material which must be disposed of by reusing it within the industry is also clearly of benefit. This is why many manufacturers have already begun using recycled materials where appropriate.

"*Using recycled aggregates reduces the need to quarry, saving natural resources. Recycling waste into aggregates reduces the loss of resources to landfill, and reduces pressure on landfill capacity. When used locally, recycled aggregates reduce the impact of transport and cut carbon emissions[4].*"

The reduction of waste is one of the key aims behind the drive to reduce the proportion of primary aggregates used within concrete production – but this must be carefully balanced with the need to produce concrete of a top-level standard, especially within the construction sector.

Education around the appropriate uses of recycled aggregates is paramount to ensure a comprehensive understanding across the entire industry, not only of the official regulations surrounding the use of materials, but also of best practice.

Almost a third of the construction and demolition waste produced in the UK is currently recycled for building products, road construction or land reclamation, which reduces both the amount of material sent to landfill and the need for new primary materials. However, while the use of recycled

aggregates is to be encouraged within certain sectors, their use in structures where concrete needs to be of the highest strength and durability should be approached with caution.

Around 75 to 80 per cent of secondary and recycled aggregates are thought to end up as sub-base and fill, including use in road building and airfield pavements[5].

Unknown or hazardous materials:

There are manufacturers who are using genuine recycled materials which have reached the end of their useful life in their current format – where the make-up of those aggregates is known and where they are tested to determine their strength and used only in places where it is appropriate - but not all are.

Problems arise when the recycled aggregates are comprised of unknown, or potentially harmful, materials. While it is absolutely right that the concrete industry looks at how it can lessen its environmental impact – and keep manufacturing costs down to keep the market competitive – regulations must be in place, and strenuously enforced, to ensure that aggregates of unclear quality or origin *and* aggregates containing hazardous waste are excluded from use in structural concrete.

Their use within the construction sector, and specifically within interlocking concrete blocks, is not to be encouraged due to the potential for the structural integrity of such blocks to be compromised if any material contained within them does not meet the regulations surrounding concrete and aggregate strength and durability.

Due to their very nature, the origins of recycled aggregates are difficult, if not impossible, to pinpoint. They can consist of a mixture of brick rubble, glass, plastics and other materials, which impacts their ability to consistently meet the requirements of the British Standards focused on aggregates. While structural concrete manufacturers have tended to shy away from the use of recycled aggregates, some interlocking concrete blocks are now being made in this way – which can drive down costs if manufacturers are reusing waste they already have on site.

While for the customer, the use of recycled aggregates could represent a cost-saving which is understandably tempting, unless they are aware of the reasons why recycled materials are not suitable in such blocks – and therefore able to question their manufacturer of choice – it could result in them using substandard quality materials unwittingly. Ultimately, while there may be savings to be had initially, the shorter lifespan of many of these substandard blocks could mean being forced to purchase replacements which would be costly in the long-term. Blocks which only contain aggregates being used for the first time are often given a durability lifespan in excess of 100 years – but it is simply not possible to guarantee the longevity of a block which contains unknown elements.

In the worst cases, interlocking blocks including materials of dubious origins have crumbled on or shortly after delivery to the customer's site, rendering them totally unusable and in need of immediate replacement. This is not only a cost and customer service concern: it also presents a clear safety issue and presents a substantial risk to the company's reputation. However, these problems could be avoided if specific regulations were put in place specifically surrounding the use of recycled aggregates within structural concrete *including* interlocking blocks.

"The relative proportions of the three main constituents within recycled aggregates (unbound stone, crushed concrete and crushed brick) can vary widely and it is generally assumed that, as a result, the performance of concrete containing recycled aggregates can vary significantly."[6]

The quoted research concludes it has been possible in many cases to use recycled aggregates which don't meet the general concrete-standard regulations. Furthermore, the use of recycled crushed concrete and crushed brick led to 'lower concrete performance than equivalent concrete mixes prepared with natural aggregates at the same water/cement ratio'.

Regulations:

BS EN 12620:

The use of aggregates within concrete is covered by the BS EN 12620:2013 regulations which govern elements including physical, geometrical and chemical requirements, as well as durability[7]. These European guidelines, adopted and published in the UK by the British Standards Institute, specify details such as the minimum oven dried particle density, particle shape, angularity, resistance to wear and fragmentation and classification of the constituents of coarse aggregates.

These guidelines should be followed by all manufacturers producing concrete for use in roads, pavements and precast concrete products. While they are not legally enforceable, British Standard regulations *'often become intrinsic to the working practices of different industries. Often this is because compliance with a standard is required within contractual terms, or because meeting the standard is essential to providing customer reassurance about quality and credibility.'* Thus, many manufacturers choose to meet the standards and comply with best practice, although there are a proportion who are less conscientious and choose not to.

The standards do not necessarily exclude the use of recycled aggregates within structural blocks, as there is no distinction made between natural, manufactured and recycled material (or a mixture), but all products including those using recycled material should comply with testing standards to ensure they are strong and durable enough for use within construction.

BS 8500:

The Europe-wide 12620 regulations are supplemented by the British BS 8500 standards which are split into two parts, the first of which looks at the specifications of concrete including exposure classes for durability and intended working life. The second part covers basic requirements relating to delivery, conformity testing, production control and transport for concrete producers[8].

BES 6001:

Since 2008, manufacturers have been able to aim for the Building Research Establishment's responsible sourcing benchmark (BES 6001) – it's now estimated 92 per cent of concrete is certified, giving companies the opportunity to reassure customers of the quality of their products. The standards look at sourcing and traceability but have no set guidelines about recycled aggregates, other than to state it is important to ensure they conform with all requirements even if the materials have similar properties to primary aggregates, and that an appropriate mix is used.

The guidelines do state there should be no set requirement to use more recycled aggregates due to the possibility materials would have to be transported over longer distances if no local recycled aggregates were available, which would clearly be contrary to any environmental benefits the policy would be intended to produce such as a reduction in carbon footprint.

Hazardous waste:

The Environment Agency:

Any waste being sent for recycling or disposal must be classified to ensure its composition is fully disclosed; various other pieces of information must also be included within the required description of the waste – for example the location where the waste was produced, a chemical and physical analysis, and – *crucially* – whether the material is hazardous[9] under the criteria defined by the Environment Agency.

Whenever such materials are transported or sold, they must be done so with a waste transfer note. However, if the waste is being reused to make a new product then the manufacturer can undertake a Court of Appeal OSS end of waste test which would mean the material was no longer defined as waste, because it has been turned into a new product which can be sold on – as would be the case if recycled aggregates were used within interlocking concrete blocks[10]. This means a waste transfer note would no longer be needed and the new product could be sold or moved without the requirement for the exact composition of the product to be disclosed, even if it contained materials which were previously defined as hazardous when they were classified as waste.

There is a cost benefit to the manufacturer of encapsulating waste materials into new products – rather than paying to have their waste disposed of correctly they are able to sell blocks containing this waste to customers, which means the company is now effectively being paid to dispose of waste. While this is a dangerous and dubious practice, crucially it's not illegal which is why new enforceable guidelines need to be put in place.

Case study: CRT Glass – Holland

In 2014, numerous UK companies raised the issue of leaded glass from cathode ray tube (CRT) screens being exported to the Netherlands, where it was being used by A Jansen BV to make concrete blocks which were then sold back to the UK in their thousands. Calling on the Environment Agency to intervene, the companies – which included Elite Precast Concrete - were highly critical, stating this was a practice which fell below the standards they were expected to adhere to and that the quality of the newly imported blocks was substandard compared to their own. The Environment Agency came under scrutiny to act but claimed they did not need to step in as the process had been 'properly regulated' by the Dutch authorities. The material was no longer deemed to be waste at the point where it was being shipped back into the UK, because it had already been used within the interlocking concrete blocks, and as such was no longer subject to waste regulations[11].

Later that year, it was reported the Environment Agency had asked for more evidence to reassure them of the quality of the product and also had restricted import to be done under waste controls[12].

But it wasn't until December 2017 that Jansen were forced to stop accepting material from suppliers in the UK and across Europe and the US following the implementation of a new Dutch Government waste management plan, which prevents the use of CRT glass in concrete products[13]. Instead of being used in interlocking blocks, the company began redirecting non-leaded glass for use in building material in the ceramic industry and leaded glass as a capping layer on landfill.

Impact and concerns:

There are thousands of interlocking blocks within the UK which are known to contain reused CRT glass. While it is known they were imported into Britain, there is no tracking system which would determine where these blocks are now situated and, while there has been coverage of the issue within the industry press, there has been no widescale warning issued to raise awareness among those who may have purchased the blocks directly from the company, or may have come into possession of them later down the line if they were sold on. While the company maintains the blocks were manufactured to high standards, because they were not imported as waste materials, they have no waste transfer notes associated with them which means when they come to be disposed of, there will be no record of their composition and the fact they contain CRT glass.

While this particular company's practices were highlighted and brought to the attention of the media, there are multiple other instances where companies have been permitted to use waste or hazardous material within concrete blocks because of the lack of industry regulation. This enables them to avoid disclosing the content of the blocks when they sell them, and because there is no legal requirement to test the strength and durability of concrete - only guidelines which suggest the minimum values – blocks are in circulation which undoubtedly do not have the same strength as those comprised only of primary or secondary aggregates.

There are dual concerns: blocks which are not of the highest standard represent both a financial risk and a health and safety one – these products simply cannot be guaranteed to last the same length of time as those using aggregates from a known and completely safe source. *And,* either the products cannot be recycled because it is known they are already from a recycled source or, in the case of hazardous waste, when that product comes to the end of its life, it is likely to be crushed and that hazardous material would then be released into the environment unknowingly.

The risk to the reputation of the industry, the reliability of the products which are being sold, the environment and of course to the safety of those who are in close contact with the blocks once they

are placed in situ is so great, regulations must be tightened and enforced to ensure this practice does not continue into the future.

"With such extensive use of the material, discovery of any shortcoming or problem associated with concrete or reinforced concrete structures will become a matter of considerable public concern – both from a safety perspective and associated costs of rectification[1]."

The future of the industry: enforcement and eradication of hazardous waste

The Holland case study - and the knowledge other companies, both those based within the UK and those who import into Britain, are employing similar practices - raises a series of important points for consideration to secure high standards within the concrete industry going forward:

Where are the Dutch blocks now?

Short of the immediate destruction of every single interlocking concrete block, which would clearly be impractical and an entirely over the top reaction to the actions of a certain number of companies in what otherwise is a very ethical industry, there is little which can be done to comprehensively tackle the issue of the thousands of blocks containing hazardous or unknown materials which have already been distributed across the UK. What should be issued however is a widespread notice which reaches as many potential customers as possible to educate them about the possibility of blocks containing CRT glass or other hazardous materials. Customers who may have purchased the blocks and the waste plants who will receive and be charged with disposing of the blocks at the end of their life need to be aware of the potential harm the waste within these products could do. Where possible the blocks should be recalled, but at the very least those who may have bought or will be coming into contact with them should be aware of the risks.

Stopping the use of hazardous materials:

More must be done to stop the use of hazardous materials within structural concrete – lessons can be learned from the Government plan put in place in Holland. A thorough investigation must be undertaken by the Environment Agency to gauge the extent of the problem, and the reclassification of hazardous waste once it has been reused within a new product should not be allowed to happen. Allowing, or doing nothing to stop, the use of such material gives the impression this is an acceptable practice and keeps the door open for more companies to do so in the future. While ethical and legitimate companies will continue to aim for best practice and comply with guidelines, clear rules (and sanctions when those rules are not complied with) must be applied to increase the chance of catching any companies with unscrupulous practices.

Better regulation of the use of recycled materials:

With a constant push for the use of more recycled materials within construction, and current regulations making no distinction between the types of aggregates used within concrete, it is no wonder there are blocks out there which simply do not meet the high standards which are expected of building materials. The acceptable uses of recycled aggregates and – more importantly – the

applications where solely primary or secondary aggregates should be used, need to be clarified so manufacturers have a clear set of guidelines to work from. A lack of knowledge, or an ability to work outside the remit of best practice within the industry while still operating perfectly legally, should be clamped down on in the future.

Research:

There is a distinct lack of research about two important aspects of using waste within concrete blocks: firstly, the impact that the use of such materials has on the block's overall performance**,** including its strength and durability – and as such its suitability to be used within a structural project. Secondly, what happens to the waste at the end of the block's life and the subsequent impact this may have on the environment.

Undertaking research into the use of recycled aggregates within concrete – and specifically within interlocking blocks – would enable the relevant authorities to make sound decisions about how to regulate the industry going forward. Publicly-available research would also empower customers by giving them the opportunity to better understand the consequences of their choices when it comes to purchasing concrete and the contents within it - knowledge they don't yet have access to. It would in-turn increase transparency and standards within the industry by promoting best practice and supporting the companies who choose not to use recycled materials; educating new companies who wish to be conscientious and understand thoroughly which materials they should be using and why; and simultaneously eradicating companies who currently use materials of a dubious or unknown source to claim ignorance when questioned about their practices.

The lack of widely-distributed evidence which could be used to drive up standards within the industry and guide future tightening up and enforcement of regulations gives a green light for the problem to worsen over coming years. While many within the industry have anecdotal evidence of the issue, without the backing of properly conducted research this is simply not enough to affect large-scale change and the long-overdue updating of regulations.

If the relevant authorities continue to essentially ignore the problem by not researching it thoroughly, this means there is no real knowledge of exactly how widespread the issue is, and how severe the repercussions could be of using this recycled waste – both in terms of the block's performance and structural safety, and what happens at the end of its life. The longer this situation continues, the more blocks are being made which include encapsulated waste either imported or circulated around the UK.

Enforcement of existing rules:

While there are regulations currently in place, they simply act as guidance for manufacturers wishing to comply with best practice. They are not legally enforceable and those who do not comply with them (for example by using waste materials which are a by-product of another part of their company rather than having to purchase primary or secondary aggregates) may be able to reduce their manufacturing costs, either unfairly making more profit than their competitors or passing these savings on to their customers thus being able to offer lower prices to customers who may not realise the inconsistency in quality between their products and those manufactured by other companies.

While there would be a cost and time implication involved with the introduction of more stringent enforcement of the existing rules surrounding the type of testing which should take place before concrete products are sold or used, this has to be balanced with the significant advantages environmentally (when it comes to products being recycled at the end of their life), as well as to the overall quality of products and to safety. Allowing unregulated blocks to be imported or manufactured within the UK is a ticking time bomb and an issue which should be addressed now, rather than following a disaster which becomes more likely the longer potentially substandard blocks are continued to be allowed to be made.

Use of the law:

There is a strong evidential case to be made that the quality of interlocking blocks and other structural concrete products should be regulated by law. Refreshing the current guidelines to provide specific advice on recycled aggregates and then making them legally enforceable would mean every manufacturer would have to make concrete of a certain standard, provable through regular testing, to be able to trade within the UK. As well as standardised testing, companies would have to clearly state the exact composition and source of the aggregates within their products. This would regulate the industry, minimise the risks by driving up quality and ensure a level playing field – with companies unable to get ahead by using substandard materials at a lower cost to themselves, or avoiding paying to dispose of their waste by instead using that waste within concrete products. This is of clear benefit to customers, as they will all receive a quality product regardless of which manufacturer they choose, but is also advantageous to the industry as a whole due to the associated increase in standards.

Customer knowledge and awareness:

Part of the reason unknown recycled or hazardous materials have been used within concrete blocks up to now is the lack of awareness from customers. While they may choose a company based on factors such as cost or turnaround time, they may be unaware of the difference in quality which can

occur as a result of the lack of enforcement of the guidelines. They may be unaware of the regulations surrounding the industry, or they may assume every company abides by those regulations. Regulatory agencies must work together to come up with effective ways of increasing knowledge of the standards expected within the concrete industry, at the same time as tightening up the enforcement aspect of their work.

Conclusion:

Recycling as a general principle is to be applauded, and the more that can be done to educate all manufacturers and customers about the appropriate uses of such materials, the better. However, structural concrete such as interlocking blocks must be subject to the highest quality checks due to the grave implications if the product was to fail, and the environment impact of being unable to recycle the materials at the end of their life in their current form.

More must be done to ensure regulation across the industry, and stop unscrupulous firms making money from risky practices such as encapsulating hazardous waste within concrete blocks. There have already been issues resulting from blocks of dubious quality being distributed across the UK, and the potential for more serious problems to arise the more of these types of blocks are manufactured is high.

Agencies involved in the regulation of the industry must act now to begin a programme of better enforcement of the guidelines, research into the specifics and potential impact, and updating the rules to clarify the appropriate and inappropriate uses of recycled and hazardous waste within concrete.

Sources:

1. Cement and concrete as an engineering material: An historic appraisal and case study analysis | https://www.sciencedirect.com/science/article/abs/pii/S1350630714000387
2. Scottish Environment Protection Agency – Recycled aggregates from inert waste | https://www.sepa.org.uk/media/162893/production-of-recycled-aggregates.pdf
3. Mineral Products Association – Use of recycled aggregates in concrete | https://cement.mineralproducts.org/documents/FS_6_Use_of_recycled_aggs_in_concrete.pdf
4. WRAP - Recycled aggregates: guidance for contractors | http://www.wrap.org.uk/sites/files/wrap/16553-02%20SME%20fact%20sheets%20-%20Contractors%20WEB.pdf
5. The Concrete Centre – End of recycling | https://www.concretecentre.com/Performance-Sustainability-(1)/Material-Effieciency/End-of-life-recycling.aspx
6. Recycled aggregates in concrete: a performance-related approach | https://www.researchgate.net/publication/250072972_Recycled_aggregates_in_concrete_A_performance-related_approach
7. BSI - BS EN 12620:2013 Aggregates for concrete | https://shop.bsigroup.com/ProductDetail/?pid=000000000030212560
8. The Concrete Centre – BS 8500 | https://www.concretecentre.com/Concrete-Design/Design-Codes/BS-8500.aspx
9. Gov.uk - How to classify different types of waste | https://www.gov.uk/how-to-classify-different-types-of-waste
10. Environment Agency – Turn your waste into a new non-waste product or material | https://www.gov.uk/guidance/turn-your-waste-into-a-new-non-waste-product-or-material
11. Recycling Today - UK glass recyclers protest EA decision | https://www.recyclingtoday.com/article/uk-crt-glass-export-holland/
12. Let's Recycle – Agency seeking further evidence in CRT dispute | https://www.letsrecycle.com/news/latest-news/agency-seeking-evidence-crt-dispute/
13. E-Scrap News – CRT-to-concrete outlet suspends glass acceptance | https://resource-recycling.com/e-scrap/2018/01/11/crt-concrete-outlet-suspends-glass-acceptance/