Puurakentamisen kiertotalouden ratkaisut -selvityshanke

Raportti 4

Circular economy during construction

Study on the use of recycled materials in buildings and interiors in the UK

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Raport 3

Industrial timber construction in marine conditions

Study on the use of recycled materials in buildings and interiors in the UK

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Introduction

This paper addresses a range of issues associated with the potential for reuse of recycled building materials at the Jätkäsaari Circular City Village development project; abbreviated throughout as "Jätkäsaari." This is following the admittance of the project into the City of Helsinki Kehittyvä Kerrostalo programme (Emerging Apartment Building Programme). The scope of materials considered has been limited to concrete and aggregates, brick, timber cladding, structural steel, structural timber and floor finishes. In reality there are also other types of materials which could be considered for reuse at Jätkäsaari and these should be thought about in the context of what is likely to be available in the time interval of the project.

The focus of this project is on what we do in the UK, with a strong emphasis on England and relevant English regulations, as construction culture can vary between the UK nations. London is a key driver of change in this reuse and circular economy space and so much of this innovative work centres around projects and practises in the wider London conurbation.

There is that old saying that; "there is nothing new under the sun"; but it is surprising how apposite this is to the subject in question. For just over 1,000 years, between 410AD and 1441 all of the brick buildings in England were built reusing bricks from Roman ruins, and not from any newly made ones. When the Romans left in 410AD they took their brick making know-how and skills with them, and local manufacture did not return to England until Flemish brick makers came in 1441 to build the beautiful Herstmonceux Castle in 1441, out of locally available clay. The Romans also had policies around the importance of the reuse of materials; just as the EU and UK are now doing likewise in the modern context of circular economy. They recognised that the reuse of old building materials was a specific skill set and a distinctive logistics process that was different from the manufacture and use of new building materials; we are just now beginning to climb up this learning curve ourselves in the sense of a wider systemic approach.

There will be considerable challenge with the reuse of materials at the Jätkäsaari project and it is hoped that the team are able to give the time and effort to make it worthwhile. Pressures may make this more of a pilot project showing some examples of what can be done; but if circular economy and climate change objectives are to be addressed then it is hoped to be more than that; the start of a process of cultural and systemic change in the construction and housing industries around the way in which building materials, in whatever form or status, are seen; fundamentally important city resources and assets for the present time and for posterity.

It is not just amazing how much with clear reuse and recycling potential gets thrown away, but how on current trends this lack of diligence to reuse and recycled is likely, in reality, to continue. Policies are one thing, every day reality and practise is quite another. As we say in England, "it is time for us to pull our socks up"

1. Background to the reuse of [recycled] materials in the UK

The use of salvaged and recycled materials in the UK goes back a long way. One of the things that we said in our presentations to the City Of Helsinki was that because English forests and woodlands were so depleted by the Neolithic era we have a longer history than most in this practise of reuse. Whilst England and the wider UK as well is rich with resources, this resource richness has been diluted by relatively high and ever increasing population densities and thus greater demand for materials.

However, the reuse of materials is a long established practice. With small amounts of what we may consider to be industrial type production going back to antiquity, as well as poor transport infrastructure allied to dangers associated with journeying, it would be obvious for one to use what was already available locally for construction. This could often involve the reuse of materials from abandoned buildings and already salvaged building materials offered for sale, as well as whatever natural resources and new materials were also available thereby; timber, stone and turf.

The most extravagant example of this was the use of good quality cut stone from the Roman built Hadrian's Wall, which runs for 73 miles between Wallsend on the River Tyne to Bowness-on-Solway. Well before the Romans had left England, Hadrian's wall was redundant as his successor Antoninus Pius abandoned it and built a new barrier much further into Scotland. It seems highly likely that it became a useful source of building materials early on as there were mandates from Rome for the reuse of materials in order to save money and help the economy and here we are circa 1500 years later just now beginning to recognise that too. There was, unsurprisingly, a recognition by the Romans that the reuse and recycling of materials was a specific skill set requiring experience and expertise, and, again that is something that we are now in the process of learning.

Buildings which were constructed from the expertly cut and dressed stone of Hadrian's Wall include Abbey Church at Lanercost, Hexham Abbey, St Andrew's Church Heddon on the Wall, miscellaneous farmhouses, building extensions and the like. Indeed, as recently as the early 1970s people were still taking stone from Hadrian's Wall to construct house extensions until English Heritage, the owner, finally took steps to prevent this from happening and the wall is now preserved for posterity. There is even a specific term for the phenomena of reusing stone and other materials from old buildings in newer ones and that is: Spolia.

It seems likely that the usage of specific carved and decorated stones by the Church in the construction of new structures and buildings was to persuade the English that they were the successors to the Roman Empire; a belief that was carried through very strongly into the hey day of the British Empire.

So we have two issues; firstly the utility of reusing good quality building materials and also secondly any messaging or meaning associated with this. The way in which carvings and other ornaments were used gave specific messages to the congregation and so this aspect of meaning is something which we could always consider in the reuse of materials: What can the reuse of this material at Jätkäsaari specifically say about the development project and what it means to live here?

Throughout the medieval era it is evident that materials were constantly being reused and recycled into new buildings. Indeed, whenever one sees an English pub named "The Ships Inn" it is quite possible that the timber used to construct the building was derived from an old ship. One of the most famous examples of this is the Old Bell pub in Gloucester where

it is claimed by a local historian that timbers from the Mayflower ship which transported the Pilgrim Fathers to America were used. Skilled carpenters were quite able to construct ships or buildings from salvaged ship timbers. The economics and logistics of this would have made sense.

Going into the modern era and specifically during and after the second world war, it became common place to use old materials in new buildings. This happened initially after bomb damage had occurred and where there were extreme shortages of materials for new construction; bricks, roof tiles, timber and joinery in the main; these were readily available from bomb sites and simply had to be used because there was otherwise nothing else available. As fashions changed in the late 1960s going into the early 1970s a focus on conservation of existing buildings became widespread and popular and most especially in the newly architecturally designated 'conservation areas'. In these areas new buildings had to fit in aesthetically with what existed already as modernism was quickly losing its appeal. This included the reuse of old bricks and roof times in particular but also feature elements such as old ornaments, fireplaces and landscape decorations. The most common use of this approach nowadays is in the construction of new extensions to old buildings were there is likely to be a planning condition which states that: " bricks and roof tiles to construct the house extension must closely match the existing materials. No materials may be used until the conservation officer has given approval. " Inevitably then a whole industry around salvaged building materials has grown up in the UK around this need, with some specific stock bricks from the Victorian and Edwardian eras commanding higher prices than newly manufactured bricks. It would seem that this practise in prevalent in both the US and in France.

The writer's father developed an apartment and housing scheme in Dover in the early 1980s where the external walls were built entirely from salvages bricks which were carefully taken down from the existing buildings on the site which were demolished; the bricks were carefully disassembled, cleared of mortar, cleaned and inspected by the engineer and then relaid to form the walls of the new housing. Years later in the mid naughties we took the opportunity to construct a new development access road for a large urban dockside regeneration project in Middlesbrough entirely from salvaged granite blocks (granite sets). This was so convincing that an elderly local man was adamant that the road was indeed the original dock road because he thought that he remembered it from his childhood. So this approach can be effective at making buildings fit in well to the existing townscape and architecture.

The above represents some early trends in the reuse of materials in new buildings which come from culture, utility, convenience, appropriateness, conservation/fitting in factors which one may characterise as mainly these days qualitative drivers to which we should now add further drivers such as sustainability and environmental requirements were not prevalent or typical before.

The Department for Environment, Food & Rural Affairs (DEFRA) reported in the February 2018 edition of UK Statistics on Waste that in 2014 the UK generated 202.8 million tonnes of waste. Construction, demolition and excavation was responsible for 59% of this total. However, the recovery rate for non-hazardous construction and demolition waste in 2014 was 89.9%, which placed the UK ahead of the EU target of 70% by 2020. This is because waste management and recycling practises on UK construction sites have been improving from the early naughties, so whilst the UK construction industry remains to be one of the largest contributors of waste, it has progressed a long way with better material recycling habits.

We should point out here, however, the difference between the rate of reuse of materials on the one hand, and the rate of recycling of materials to make new materials on the other. Whilst UK recycling rates are indeed high, the rate of reuse of materials is low. Indeed, the

rate of reuse of materials is estimated to be around 1-5% depending on the material; 1% for general materials and 5% for steel, typically.

It is also worthy of note that 55% of the global industrial carbon emissions come from the processing and manufacture of five main materials: steel (25%), cement (19%), paper (4%), plastic and aluminium (3%). Of these materials, the UK construction industry is, unsurprisingly, the primary consumer of cement and is also responsible for the consumption of approximately 25% of plastic, 26% of aluminium and 50% of steel
A real and pressing problem for the UK is that we are running out of landfill sites in which to place any unused waste material and this, together with the landfill tax, has been a big driver for industry to re-use and re-cycle. Landfill Tax costs at £96.70 per tonne of construction waste going to landfill in the UK can significantly impact construction project margins which are sometimes quite thin; so that there is a real profit motive involved here. Cleverly the landfill tax rate has been rising constantly over the last 20 years as a ratchet to push the construction industry to recycle. Reusing building materials in new projects could significantly reduce the industry's carbon emissions.
https://www.thenbs.com/knowledge/construction-waste-and-materials-efficiency

The challenge is now framed in terms of the circular economy so that the challenge is more broadly based. It is no longer a more ad hoc approach, but rather a completely different way on conceiving of materials and resource use so that higher value building materials are to be kept at the designed use as long as possible; even if this means designing building for disassembly so that they may be transported to a new project and incorporated there. Residential buildings with design lives of typically 60-100 years can often outlast commercial and retail buildings with design lives of 20-30 years and so this design for disassembly approach is arguably more relevant to the latter.

One of the ways in which we can conceive of existing buildings is that they can support and drive progress with circular economy by being thought of as material stores for future construction. In this frame of thinking one will first think about what existing materials may available rather than seek to use new materials; and this is the critical point, to then orientate one's approach to design accordingly.

Although the UK has an, at times, illustrious history and competence with regard to the reuse and recycling of construction materials, one must look at this point to the Danes and specifically projects in Copenhagen which have really taken this thinking to a whole building and holistic level. Lendager Group's Resource Rows project, Copenhagen in worthy of study. Here, the 92 homes were built mostly from recycled construction materials. The core architectural concept was to reuse materials and this was translated, for example, into a façade made up of a patchwork quilt of panels of recycled brickwork.
https://lendager.com/nyheder/the-resource-rows-2/

85% of the materials to make the 'Waste House' at the University of Brighton was from household and construction site waste. The project is a little gimmicky but it does make the point about consumer waste.
https://www.brighton.ac.uk/research-and-enterprise/feature/brighton-waste-house.aspx

The issue of construction waste can also be framed around concepts of material efficiency. Because it is not just about the reuse and recycling of materials but also around design strategies and approaches so that less material is used. An example of the latter which the writer drove was the use of post tensioned concrete floor slabs in apartment building developments which resulted in significant reductions in both the use of concrete with much thinner floors slabs but also the use of much less steel reinforcement. So when one is considering a reuse and recycling approach this should always be done in conjunction with notions of material efficiency.

From experience, factors which need to be considered in the use of reused and recycled materials are:

- Seek to use fewer materials resources as the amount of recycled material cannot always be determined and may be less than is available.
- The use of reused and recycled materials must be considered from the earliest stage in the project as it can be disruptive to the design process to introduce these issues later on and there also may not be any time left for planning, co-ordination and logistics.
- Source materials more locally thinking about what is available to closer to the project.
- Get more creative and thoughtful about the design; possible limitations on the availability of materials can drive interesting and innovative design solutions which are based around material efficiency.
- Think about optimising between initial capital cost and overall lifetime cost in the same way that one would do with any new material choices and selection; reused and recycled materials that may have a low or strongly compromised service life are unlikely to be the best choices however attractive they are.
- Likewise think about maintenance in the same way as for new materials; what is going to be easy and cost effective to maintain; what is not going to wear out quickly or easily.
- When ordering be careful to use the same approach as for new materials; don't over order and do pay attention to careful and diligent material scheduling.
- A particular issue is programme and timing; sometimes materials can only be available significantly in advance of being required for the construction programme in which case provision for the cost of storage needs to be considered. This may also involve any cleaning, repair and rework of material to be incorporated in the construction works. In this regard sufficient time must be allowed to enable construction professionals such as the architect, structural engineer and even potentially the MEP engineer to inspect and approve any items (in the UK the reliance here would be on the professional and not the building control inspector and this may be different in Finland where the local authority building inspector may also want to be able to inspect any materials prior to their incorporation into the works).
- In all of this is it critically important that a collaborative approach is taken across the design and professional team and that there is good communication at all times. This type of approach means that the project will need to be managed in a different way to what is normal and this needs to be communicated so that people don't hit a wall of difficulty because they haven't planned for this approach in advance and discussed it.

The future for this approach in the UK looks bright with cities such as London and Brighton now adopting policies for circular economy and materials reuse and recycling. The effect of this is that those organisations are also the planning authorities and so through circular economy policies they can impose planning conditions on developers to implement these kind of approaches. In the case of London, Large-scale construction projects now need to provide Whole Life Carbon Assessments as well as Circular Economy Statements in a driver to address and meet net zero carbon commitments.
https://www.london.gov.uk/what-we-do/environment/smart-london-and-innovation/circular-economy
https://sussex.constructingexcellence.org.uk/wp-content/uploads/sites/8/2020/05/BHCC-CE-summary-Constructing-Excellence-12.03.2020.pdf

We are moving very quickly now from circular economy being a good idea and a differentiator towards being a business requirement in the UK and this will require a change of culture in industry, albeit there is a good baseline of experience in this area already and so much to build on as it were in this exciting endeavour.

2. Barriers experienced in the UK to the reuse of [recycled] materials and how these were overcome

2.1 Overview

A number of barriers have been experienced over the years and key aspects of these are listed below and will be dealt with in relation to those specific elements:
- Quality Control
- Design specification
- Logistics
- Building regulations
- Building warranty

In addition to the elements cited above, there can be over arching barriers around:

- Project and wider industry culture and the simple idea that new buildings should be made out of new materials
- Uncertainly and the desire for clients, professionals and constructors to avoid uncertainly which can be a tricky area to address; the culture of design and construction is to design out and risk management out uncertainly and not to embrace it
- Fears from a marketing and sales perspective that potentially the materials are somehow of questionable quality and not suitable for new construction

Culture; There is always the opportunity with a construction project to introduce a specific culture and way of doing things on a project which is different from any other project. The writer has used this concept successfully on some large developments where specific cultural change was necessary to success. Key to this is working out what that culture needs to be so that it can then be communicated on and delivered into the project The writer suggests that a short seminar is prepared for the project participants that explains what the key project objectives are and how specific behaviours and outlooks can contribute towards the fulfilment of these. This should start with an explanation as to why there is a desire and ambition to reuse materials; we should never assume that it is obvious to project team members why a decision has been made without them being briefed about it. The writer's experience with this is that people will quickly engage with a process such as this when they can relate to it; maybe in their own home or summer cottage they have already reused or used some older materials for a specific purpose. Remember this can often be a qualitative factor; of course quantitive factors need to come into play as well with regard to City of Helsinki, Finnish national and EU targets. Whilst it may seem quite unusual to use older materials in new residential developments in Helsinki it is quite common to see examples of this in the hospitality industry, and specifically in pubs and restaurants, in Helsinki. This is because those businesses want to create a particular atmosphere or feeling in their establishment to make it attractive and comfortable for the customer. There is no reason to not apply this same qualitative factor to new housing which can sometimes feel sterile and soulless when it is first lived in as all of the materials are new and no doubt industrially produced. Indeed, as mentioned above, when the materials have some specific relevance or meaning then this may add something especially attractive or interesting. There are a number of items from when the Jätkäsaari port area was a functioning sea port which could be incorporated into the project which could add a lot of interest to the new apartments dwellers; such as gates, ironwork, fencing, bollards, signage, equipment etc.

Uncertainly: one must be more attentive to design, scheduling, storage, delivery and installation issues with reused materials than with new materials. This is going to introduce at

times headaches for the designers and project manager and construction manager who will inevitably question why a more difficult and challenging route has been chosen for a project; especially when, as for most projects, there are already a wide arrange of challenges. So the uncertainly factor can only be addressed through applying the highest degree of professionalism and attention to detail and this is also part of the culture factor as above.

Customer fears: This can be the hardest challenge to overcome because people may, after all of the explanations, feel that they are not getting their money's worth. Older is not as good as new, they my feel. Again, education and explanation is key; specifically what reused and recycled materials have been used must be listed out and for each case carefully explained why they have been used. This explanation should include reference to all of the potential barrier factors listed below: the City of Helsinki building control has approved it; the engineer or architect (or both) have inspected and approved it; the building insurance/warranty provider has given it their backing. Don't wait for them to raise the concerns and then wonder how to address them; put it all in the marketing material and also in the building handbook.

2.2. Quality Control

Quality control issues around the reuse and recycling of materials require designers and constructors to think in terms of quality control and manufacturing logic and not just the normal process of choosing building materials and systems out of a brochure or web site. This is a culture change issue. There are two scenarios for this process;

1 - A demolition contractor/building owner is given a specification which includes qualitative descriptions of the materials, any applicable standards, and this demolition contractor then supplies to the client the required quantity of materials with a certificate of conformity as regards compliance with any relevant standards (industry standards may not always be available) and also confirming the absence of any contaminants with any accompanying chemical tests that may have been done as proof.

2 - The client decides to work with an existing building owner to get materials from a building to be demolished, or refurbished for use in a new project. In this case there needs to be quality assurance and quality control process applied.

Just as one would extract stone from a quarry in a way and using tools and machinery that did the least damage to the material so that useful product can be made out of it, so the demolition process must be carried out in such a way that the best quality and most usable materials can be yielded for later reuse.
Quality control starts with the idea that the process of demolition has to be different from the norm; one cannot pull apart a building with the violence normally associated with demolition; this process should really be thought as disassembly so that damage to any materials is minimised. This requires that there is a good understanding of the structural and construction logic of that building; what is structural or non structural timber, infill brickwork or structural brickwork. The process of getting the materials out requires a good understanding of how the demolition process has to be done differently. So for this to be done properly there should be a method statement for disassembly which sets out

- which materials are to retained and why
- where they are located in the existing building
- what condition they need to be in for viable re-use
- what quantity is required in each case

Just as the construction process is carefully and closely supervised, so this process also needs to be subject to close and careful supervision. This is a critical factor otherwise it is quite possible that the damage done to materials during the demolition process could render them unusable. Good photographic records should be taken so that it is clear what condition the materials are in before they are removed from the building.
The process of quality control of materials to be reused must start with an awareness/survey of the environmental conditions in which they have formally been used. This is because they may have been contaminated in their previous use by asbestos, mineral oils, lead paints and the like. This means that there must be documentation accompanying any materials to be re-used from the demolition phase to confirm that they are clear of any contaminants.

If contaminants were found at this stage then they must be removed so that the material does not become classified as hazardous waste. In practical terms this may be less likely with materials such as bricks, roof tiles, but may be an issue with timbers, aggregates, concrete (concrete is hygroscopic and may over its life have absorbed all kind of contaminants through water absorption). In any event, the checks must be carried out. In the case of timber there is the need to carry out chemical tests to ensure that the timber does not contain decay fungi which may being dormant; decay fungi can be present in timber but not fully activated if the moisture content is low and this could cause problems in the new building is there is a water leak and the timber then becomes saturated. The next stage having assessed that the materials are free from contaminants is to carry out a closer inspection of their condition to ensure that they are suitable for their intended use. This should involve several members of the design, construction and client terms. The client needs to be sure that the quality of the materials to be reused in the building is appropriate and is what they want; likewise the Architect should inspect the materials for a similar purpose; the structural engineer will have different reasons around structural criteria.

There are different scenarios for reuse. In some cases the material may simply be reused and incorporated into the new works as it is; such as in the case of brick, roof tiles, timber. In other case, for example concrete, the material to be reused may need to be reprocessed into, say an aggregate. Relevant standards have to be checked and in general terms a quality assurance process involving the use of relevant standards is necessary; for example for the production of aggregates from re-cycled concrete then EN 12620 and EN 13242 will apply.

For bricks the first question is what is the planned use of them and specifically is this for a structural or non structural wall ? In both cases, even where the existing use of bricks was in a structural/load bearing wall, one should still carry out tests on a sample of the bricks to assess their load bearing capacity in accordance with BS-EN 771. An issue in the UK is that bricks from earlier times are in imperial measurements and not in metric measurements and it is not known when the Finnish construction industry became metricated and so this check may or may not apply. Once the strength of the bricks has been established then they would need to be cleaned to remove any mortar from them which can be done if the mortar is lime based, but which can be quite difficult if the mortar is cement based. In the case of the latter then the bricks may be more suitable for reprocessing for use as aggregate material for landscaping, as an example. The bricks should be wire brushed to remove dust and extraneous materials and then stacked onto timber pallets for transport to the construction site where they can then be safety stored prior to use.

Timber needs to be carefully inspected. The quality of timber used in buildings from the Victorian era can be of much better quality than modern timber and thus appropriate for reuse; Victorian pine flooring was made from dense first growth forest timber which is much higher quality than new wood typically used nowadays. The first check with timber is to establish what species it is and this can be done most reliably by sending some samples of it to a testing agency who will establish this; from this and a visual inspection by an engineer of the timber the structural grade can be established (although an engineer is unlikely to certify this without actual tests being carried out). The structural grade of the timber together with

the various dimensions can establish its overall strength/load bearing capacity and thus advice can be given by the engineer on where it can most suitably be used. The timber should be de-nailed to remove nails and checked for any defects, rot or damage. Where the timber has any rotted parts, cut outs, or notches, then new timber of the same grade should be spliced in to make good. The timber should be gently shot blasted to remove any loose material (so not heavily done otherwise the surface of the timber can be damaged) and then fumigated to get rid of any biological contaminants by spraying (for example) a borate glycol solution onto the surfaces. This solution will penetrate into the wood and give it some protection against rot. As with the bricks, the timber should be carefully stored once on site and ready for use.

Steelwork and concrete/aggregate quality control matters are dealt with in the example sections of their use.

There can often be a 'chicken and egg' situation arise with the reuse of materials; does one seek out materials to fit into an existing design (in the same way as for new materials) or does one design the building to suit what reusable materials are available ? In the case of a complex apartment block such as this construction project the latter is, in the main, impractical; although as noted later a more imaginative approach could be taken with regard to the fit out of the apartments. It should always be remembered that there may be good quantities of good quality and new materials from the waste of new construction projects, so that reused materials may simply be new materials that were going to be otherwise cast off as waste by the contractor. It would seem reasonable and appropriate at Jätkäsaari for letters to be sent to any contractors who are on site in that area or even further away, or about to start on site, to see what material waste streams they may generate and how and where these can be used.

Documentation should be carefully maintained in respect of any reused materials and incorporated into the operations and maintenance manuals for the building as a whole in the same way that one would for new materials. In any event, and specifically in relation to the earlier report on CLT, the writer does not recommend the use of recycled bricks to the exterior facade of the proposed apartment block, or indeed any other reused or recycled materials on the facade, where the structural system behind is mass timber; unless some very high quality engineering bricks can be located of suitable quality. This is because of the level of vulnerability of the interior CLT to water leaks and thus the need to construct a tight weather envelope which can most reliably be done with the use of new materials.

2.3 Design specification

There are two key design specification documents required for the reuse of materials;
1 - building performance specifications to describe the functions that the reused materials must perform
2 - remanufacture/reworking specifications which describe what needs to be done to the reused materials so that they can perform the functions set out in the building performance specification. The first type of specification will be a function of the technical and engineering design and will not vary; that is what is required for building regulations and other functional requirements to be met. These should be drawn up early on so that there is good clarity on what is required. The second type of specification will vary depending on what material is available and how much re-working, if any, is required so that it can meet the building performance specification.

The craft of writing good specification documents is important in conquering the reuse of materials learning curve for a number of reasons:

- People need to feel confident with the idea of incorporating old materials into new works, new buildings; whilst this may not be a big issue for more miscellaneous items such as floor boards, furniture etc., it can be where building performance issues are of importance; the glossy brochure for the new needs to be counted in the reuse of materials with nitty gritty technical literacy as part of the confidence building.
- The building performance specification needs to identify specific building performance requirements; for example if salvaged timber is to be installed to the interior of the apartment foyer as a wall cladding feature, then a specification for that wall cladding needs to be drawn up in the same manner that it would be for any new materials. This may need to take into account a number of building performance issues in relation to, for example, the resistance to fire spread, sound absorption characteristics, aesthetic appearance, durability, fixing arrangement. This may limit which species or thickness of timber is used.
- The building performance specification is also a key means of communicating what is required from the salvage companies, building owners, demolition companies etc., so that they can then respond to the requirement for materials in a good, coherent and timely manner.
- Carrying on with the example for wall cladding, once a source of timber is located that appears capable of meeting the performance, then a manufacture/reworking specification needs to be drawn up as regards inspection, investigation for contaminants and any decontamination needed, surface cleaning process, any repairs or strengthening, painting or other coatings to be applied and then arrangements for fixing; all have to be carefully thought about.
- It is important to convey the seriousness and dedication of this whole reuse approach to the construction companies who may be tendering for the construction work; they generally respond with seriousness when they see technically based building specifications rather than something may seem vague.

To support this process of specification writing, it is important that the technical parameters of any proposed materials for reuse are investigated in some depth; their physical character; chemical composition; structural strength and character, sound absorption, moisture permeability, durability, resistance to fire; as would be done for any newly manufactured material. This process needs to be systematised so that it is embedded and integrated into the design process; the character and performance of materials needs to be quickly and cost effectively established. The team should consider forming a partnership with somebody like VTT who are an excellent technical university and who will no doubt have the laboratories and skills in-house to fulfil this function. An issue is how this can be done in a cost effective manner. From these assessments convincing technical documents can be created which will give confidence to building regulations officers, warranty providers, the building owner with regard to the materials proposed for reuse. Clearly this level of investigation will not always be required and this will be dependent on the requirements of the building performance specifications.

It should also be remembered that a key sustainability approach to buildings is to always question the need for a building component; what specific function or functions does it fulfil? The more functions fulfilled by any single building component the better. It is clearly not worthwhile as regards the promotion of circular economy to simply specify the reuse of salvaged materials for the sake of display; they will go out of fashion and be replaced in no time. Circular economy issues only really come into play if reused materials can perform the functions normally expected of new materials and are not just there for cosmetic or show uses.

As we can see there is little doubt that additional costs are going to be involved with this approach; not least in the additional professional design fees in drawing up the specifications for the reworking of materials, but as well as the costs associated with any necessary rework to meet building performance requirements. We cannot kid ourselves that this will not cost

additional money; you can't compete with mass manufacturing by trying to throw a nascent cottage industry at it. If this process as a core aspect of circular economy is to gain any meaningful market traction (or even market share in construction materials) then it must be seen foremost as an exercise in scaleable and organised remanufacture; it should not then be thought about as just an interesting pilot project but also as something which can be scaled up.

A further observation is the need to rediscover as a construction industry our interest and competency in building science and technology; many construction companies going back to the 70s, 80s, 90s had their own in-house research and development capabilities and laboratories. If this competency were to be brought back to those companies then there could be a good chance for the re-use industry to happen because the technical competency will then be there at scale to support it.

This document addresses the use of structural steel, concrete, aggregates, structural timber, floor and wall finishes. Further materials could also be considered for the project and these additional materials could include for joinery items such as doors, architraves and skirtings; ironmongery for doors and windows; plumbing items such as reconditioned sanitary ware. A good place from which to source some or all of the latter may be in hotel refurbishment projects where there is a huge level of waste; hotels are often upgraded simply to reflect the changing whims of the customer. The materials and equipment used is often of a very good level of specification and quality and thus at times highly suitable for reuse.

It is not known how any emerging specification documentation for the project may interface with the specification requirements of ARA. Homes England (formerly the Housing Corporation) is the key funder for affordable housing in England and it applies standards and specifications to the projects that it funds, although it does not have any standards regarding the reuse of materials. ARA may need to be consulted with regard to the proposal specifications and indeed involved in the project as a key collaborator as the approach may be appealing to them with regard to their other projects in Helsinki.

The approach to the development of specifications should consider the three distinctive areas of the building a little differently; the apartments, the ground floor shared spaces and the access and circulation spaces. Each of these have specific uses and needs and thus could be related to the reuse strategy differently.

If the development is constructed from volumetric CLT then that manufacturer should be involved from the very early stage in the specification process. One would expect that they could be particularly well suited to the integration of reused items in their factory environment and indeed this could create a seamless and efficient process which could be more suited to reuse than a normal construction environment. Salvaged materials could be delivered in raw form to their workshops where they could be assessed, cleaned/de-contaminated and then fixed into the new volumetric components as appropriate before onward transport to site.

BIM, or Building Information Modelling, is becoming more widely used in the UK although this can be more prevalent in public sector construction projects rather than new ones. BIM can assist with the information management and specification issues by having the latter embedded into the BIM model. This is something which could be explored for the project. A further benefit, although this can be more in theory than in practise, is the way in which the BIM model can assist with the operation and maintenance information so that relevant specifications are embedded in the 3d model. There is talk of building passports related to BIM but this is not something which is happening in the UK at present.

(*) the best example of a truly holistic environmental /sustainability project is the BRE Environment Building at the Building Research Establishment in Watford, London. This

combines sustainable and low energy design with the comprehensive re-use of salvaged materials in a way which in the writer's view is still unsurpassed. It stands as a inspiring pilot project but which unfortunately has not acted as the replicable office of the future that it was meant to be.

2.4 Logistics

Logistics issues are coming to the fore in considering circular economy matters in the UK. The reuse and recycling of materials can add complexity to what is an already established recycling system; and that is the complication of how to deal with the flow of materials from where they are currently installed in existing buildings to then go to the new buildings under construction. There are essentially two ways of dealing with this:

1 - Expand the provision and capacity of the reuse and recycling firms with greater areas of land and buildings for materials storage.
2 - Synchronise opportunistically between what materials are available at any one time interval with what materials are required consistent within that same time interval in new construction, i.e availability that is consistent with the construction programme, and thus potentially cutting out the need for intermediate/middleman storage cognisant that this storage capacity may not in any event be available.

The challenges with (1) are; who is going to take the sales risk ? Do the salvage/reuse materials companies purchase materials from the building owners or demolition companies and then put these materials up for sale in their warehouses ? Or does the client pre-purchase the materials and pay the salvage/reuse materials company simply to store it and to arrange for delivery when the construction site is ready to install ? Added to which is the capital cost risk of the salvage materials companies having to expand their land and property holdings commensurate with the quantity of materials that they will want to store/make available to the market. How will this be financed and most especially if the market signals on circular economic are still nascent ?

The challenge with (2) are that; there may be huge amounts of waste and missed opportunity because the two elements of provision and need don't come together in the same time interval, and also where does any working of the materials, if that is necessary, happen ?

Not all sites will have sufficient spare space for this. We can see from the previous section on quality control that it is not entirely a labour free and easy process to reuse materials. Even the scenario of the simple reuse of something like bricks in good condition which can be easily taken apart from their existing structure has elements of complication and challenge; i.e. the need for inspection, structural testing, cleaning, placement onto pallets and storage; not that far away from what is involved in manufacturing new materials.
The approach for Jätkäsaari in the view of the writer should be to consider a hybrid of both (1) and (2).
What materials are available before the time interval of construction and which could be stored at a third party location with that person or organisation (maybe a salvage company or simply a place where materials could be stored) either being paid for storage or being paid a fixed sum for the new materials as they can take the risk as regards getting the materials ready for reuse; reworking them if needed. At the same time there may be some synchronicity in terms of what is going to be available at the time of construction. It is noted that there is going to be very limited storage at the Jätkäsaari site because there is limited storage space outside of the building envelope; although there may be some storage space in the basement and also in the adjoining greenway that could be used; the latter needs to be explored with the masterplanning team to gain approvals. So in this sense one would recommend:

- That the client, architect and wider design team think very early on about what types of material they would like to use in the new development and where they would like these materials to be used. This should be a fully thought about part of the design process.
- The team should think about and investigate what demolition projects are underway or planned in the wider Helsinki area and get in contact with the building owners and/or demolition contractors to discover what might be available for use. This is an exercise where working collaboratively with the City of Helsinki would be beneficial; the city planners will be aware of what is coming up and so the City is an obvious partner in this process.

In regard to the latter it is always helpful to suspend judgement and keep an open mind. The wider project team will have a greater imaginative capacity than one single person and may find all sorts of uses for things that one person alone cannot.

There are two elements to all of this:

1 - The main construction part of the development
2 - The interior fit out of the individual apartments

With regard to (1) conventional construction organisational and programming logic will clearly need to be applied, and indeed done so with more rigour and discipline than the norm to ensure that the construction programme does not drift off course. With regard to (2) the client could take the view that for some of the apartments the occupiers will be allowed a greater level of flexibility on how, and with what materials, their apartments are fitted out and finished. One idea that one could build on is to say to some of the building tenants/owners that a number of potentially usable materials for the interior of their flats could be made available at a storage location off site and that they can select materials from that location for their apartment. This could be for non contentious materials such as doors, kitchen units (not white goods), flooring, furniture, shelving, interior decorations, lighting shades and so on. So in other words let them become, to some degree, the interior designers for their flats using salvaged materials; why not ? The writer's experience of office buildings in Sweden is that it is not uncommon for Swedes to decide on how their offices are fitted out and for them to take all sorts of domestic items into the workplace; in one case even a hammock fixed between two columns so that the worker can read documents in a relaxed manner. Why should this not also be the case with the fit out of one's own apartment ? Such an approach could be used to help with lowering the rental costs and thus helping with better levels of affordability.

2.5 Building regulations

Building Regulations in England and Wales differ from those in Northern Ireland and Scotland. Indeed, the Welsh building regulations are now moving away in places from English building regulations. We shall address the regulations which apply in England. It should be noted that these regulation are performance based and are not so much prescription based; so they are specifically designed to allow for professional skill, care and judgment in the design of buildings and the selection and specification of suitable materials. In many countries building regulations are often very prescriptive based; so, you will do this or that, like this, exactly. This is not the case in the UK and this is a very helping thing in terms of any desires to reuse materials into new construction. The onus of proof of performance is still there and this can at times be both time consuming and costly but at least it is possible to take this route if one wants to.

There are two key elements to the English Building Regulations; The Regulations which are set out in Schedule 1 of the Regulations and the Approved Documents. Simplistically, the

Regulations tells you what you must consider and think about as regards, essentially, performance, expressed as functional requirements. The Approved Documents suggest how you might wish to do it, and if you follow the Approved Documents then, barring exceptional circumstances, you will comply with the functional requirements of the Regulations. But you don't have to use the Approved Documents; you can figure out your own method of complying with the functional requirements of the Regulations and then you have to submit that method to the building control authority who will have to consider it. They can't reject it because they don't like it or don't agree with it; they have to assess it based on it's own merits and if that means they need to get outside third party expert advice then they have to do that.

Part 7 of the Regulations relating to materials and workmanship states that:
7. (1) Building work shall be carried out—
(a) with adequate and proper materials which—
(i) are appropriate for the circumstances in which they are used,
(ii) are adequately mixed or prepared, and
(iii) are applied, used or fixed so as adequately to perform the functions for which they are designed; and
(b) in a workmanlike manner.

This puts us into the realm of professional judgement; the designers and constructors decide. Operative words are 'adequate and proper' and 'appropriate for the circumstances' . There are also issues of workmanship here as well; so how to fix and apply the materials.

Going on to the Approved Document; and remember, in England you can make your own case for use outside of the approved document in you wish. To expand; "Approved Documents are series of documents approved by The Secretary of State that give practical guidance about how to meet the requirements of the Building Regulations 2010 for England. Approved documents give guidance on each of the technical parts of the regulations [and on the applicable regulations]. Approved documents set out what, in ordinary circumstances, may be accepted as reasonable provision for compliance with the relevant requirements of the Building Regulations to which they refer. If you follow the guidance in an Approved Document, there will be a presumption of compliance with the requirements covered by the guidance. However, compliance is not guaranteed; for example, 'normal 'guidance may not apply if the particular case is unusual in some way. Note that there may be other ways to comply with the requirements; there is no obligation to adopt any particular solution contained in an approved document. If you prefer to meet a relevant requirement in some other way than described in an approved document, you should discuss this with the relevant building control body."

The Building Regulations Approved Document 7, Materials and Workmanship (2013 edition) sets out requirements that must be met in terms of materials specifications and workmanship.
Relevant parts:
Performance and Limitations
In the Secretary of State's view, you will meet the requirements of regulation 7 if you satisfy both of the following conditions.
a. Materials are of a suitable nature and quality in relation to the purposes and conditions of their use.
b. Workmanship is such that, where relevant, materials are adequately mixed or prepared and applied, used or fixed so as to perform adequately the functions for which they are intended.

So now the operative words are: "of a suitable nature and quality in relation to the purposes and conditions of their use." In addition to the functional requirements around 'adequate and proper 'and 'appropriate for the circumstances'

Note that with regard to workmanship issues the operative words to be added are that the installed materials must now: "perform adequately the functions for which they are intended"

Limitations apply to the extent that any materials choices must still comply with any Functional Requirements around sound insulation, fire resistance, heat and power conservation, safety and so on. So any salvaged material used in a fire compartment wall must contribute to the fire resistance of that wall to fire spread in the same way that a new material would have to as well.

Section (1) Materials part of Approved Document 7 states that one can 'assess the suitability of a material for use for a specific purpose in a number of ways' and that this is generally done by use of materials complying with relevant standards. It is recognised that, 'many materials are construction products that have CE marking under the Construction Products Regulation (305/2011/EU-CPR). The Construction Products Regulation requires that construction products on the EU market covered by a harmonised European product standard should normally have CE marking. In addition, manufacturers of products not covered by a harmonised standard can choose to affix CE marking to their products by obtaining a European Technical Assessment.

However, whilst CE marking is one way to go, there are specific carve outs which can apply in the case of re-use and salvaged materials (or indeed any other materials) and we must remember " there is no obligation to adopt any particular solution contained in an approved document in order to meet functional requirements; the references are not exclusive and other materials may be suitable in the particular circumstances." So in the UK it is not a requirement of the Regulations that materials used in construction are CE marked; this may differ in Finland.

Ways of establishing the fitness of materials
1.2 You can assess the suitability of a material for use for a specific purpose in a number of ways, as described in paragraphs 1.3 to 1.21.
Past experience - 1.18 Past experience, such as use in an existing building, may show that the material can perform the function for which it is intended.

In this case it is clear that the onus is on the professionals to demonstrate that the material has been salvaged from a building where it previously performed adequately as a component of that building. The implication being here that the experience of use can in itself be a substitute for a design standard; it has qualified itself by virtue of its experience

Sampling - 1.19 Under regulation 46 of the Building Regulations, local authorities have the power to take samples as necessary to establish whether materials to be used in building work comply with the provisions of the Regulations.

This provision goes both ways, and in the UK it is not unusual for a building owner to commission tests on building components to establish their fitness for use. Clearly if a salvaged component is to perform a function in relation to, as before, the resistance to the spread of fire, or resistance to the passage of sound, then in circumstances where it forms a composite of components performing that function then it should form part of any performance tests that are carried out to make sure that the performance standards are met and in the same way that would apply where any new materials are used.

Independent certification schemes
1.15 There are many independent product certification schemes in the UK and elsewhere that may provide information on the performance of a product. Such schemes certify that a material complies with the requirements of a recognised document and indicates it is suitable

for its intended purpose and use. These may be in addition to, but not conflict with, CE marking.
NOTE: Materials which are not certified by an independent scheme might still conform to a relevant standard.

2.6 Building warranty

The requirements of UK building warranty providers essentially constitute a second line of defence as regards compliance with building regulations and construction quality more generally. The warranty companies put their money behind the workmanship, materials and design detail choices of the construction professionals by providing guarantees to new home owners against failure of the structural elements of their new homes over the first 10 year period of use of the building. Typically in the first 2 years of that guarantee period the warranty companies will require, via a condition of providing the warranty in the first place, that the housing development/construction company steps in and rectifies any defects that are found at their own cost. After that, and so for 8 years, the warranty company is at risk. It is no surprise then that these companies will have their own ideas on what constitutes good quality materials and good quality workmanship. The two key providers in England, NHBC (National House Builders Council) and the LABC (Local Authority Building Control) each have their own standard specifications and requirements for new construction which are detailed and prescriptive requirements and which must be complied with. It is not unusual on a London building site to see on the same day both a building inspector and also a warranty building inspector; the latter will issue comprehensive quality check lists for the site manager to diligently complete and will often require them to take photos of the work as evidence of compliance and also that any such records are maintained. Because of the free market approach typical of the UK, it has been allowed for many years now for private companies to also act as building regulations 'approved inspectors' in lieu of the local authorities (the latter are still obliged to offer the building regulations function in the market); and so one may find the NHBC as the building regulations approved inspectors and the LABC as the warranty providers; or either of them performing both functions on one site.

In both cases the housing developer will pay significant sums to get the warranty cover for each residential unit and the benefit of this will be passed on to the purchaser of each house or apartment. If the housing developer is a housing association then they will be the beneficiary of the warranty and not the renter. The warranty companies are not driven solely by minimum compliance with building regulations but also by the higher standards that are inevitably set by claims experience of what typically goes wrong, what the defects are. For the government it can take a long time to change and update the building regulations whereas the warranty providers can make changes to their specifications at short notice and without any need for consultation. If they see building failures beginning to emerge then they can act straightaway with notifications to the industry that they are going to change their specifications.

With regard to the NHBC, they require in section R3 of their technical requirements that:
(c) Reclaimed materials may only be reused with the prior agreement of NHBC. Independent certification of suitability may be required.
And that with regards to the use of aggregates that;
(f) Aggregates derived from recovered inert waste, e.g. recycled aggregate, should only be used where it can be demonstrated that the inert waste material has been fully recovered, has ceased to be a waste as defined by the Waste Framework Directive 2008 and has become a product. To this end, recovered aggregates produced by a supplier complying with a recognised defined quality management scheme such as the WRAP Quality Protocol and meeting end-of-waste criteria, will be acceptable to NHBC.

Whilst building regulations put the onus on the designer and constructor, the NHBC reserves its sole right to approve of the use of re-cycled and salvaged materials

The writer's experience of the NHBC as regards the reuse of materials, however, has been for the NHBC to approve their use provided that the engineer and/or architect certifies that the material is suitable for use; that any relevant standards or protocols have been followed in the production or any remaking of the material and that there is a certificate of conformity accompanying the material when it is delivered from either the manufacturer or the salvage company. In other words a paper trail which is to be kept safe with the construction inspection records handed over to the building owner as part of the operations and maintenance manual for the building. This approach is what one expect to see from a good and consciousness set of professionals who would want to be sure in their own minds that they are doing the right thing for the long term. The NHBC has a not for profit research arm which is the NHBC Foundation and they have carried out research into the use of recycled aggregates and from which the above guidance on aggregates was formulated. One of the factors to consider here is that in reality, and apart from the use of recycled aggregates which is increasing, there is very little reused and salvaged materials getting used in the construction of new homes in the UK; that is because the majority of them are standard suburban designs which are sold as much as a consumer product as a new place in which to live. Given this factor there is not going to be much claims experience associated with any reused materials. Indeed, for the NHBC their most common housing defects over the years are associated with roof construction and one would not be inclined to use recycled materials for this part of any construction in any event.

With regard to the LABC, they do not have published requirements which are in excess of the materials requirements set out in the building regulations.

The warranty providers do not constitute a further hurdle or difficulty in the use of recycled or salvaged materials. The NHBC, by far the most dominant provider with between 70-80% market share for new home warranties does address their specification policy as noted, but not in a way, in the experience of the writer, that hinders the use of such materials; subject always to a good and professional attitude being taken by the design and construction team.

3. Examples of the incorporation of [reused and] recycled materials into UK buildings

3.1 Concrete and aggregates

There are two key areas of opportunity; concrete structures can be broken down into aggregate which is used in the production of new concrete structures; or other sources of secondary aggregates (i.e industry waste or byproducts) can be used for concrete production. It is possible that concrete structural elements could be incorporated into newly constructed buildings and thus simply reused as they are (with possibly some minor modifications) rather than being recycled into aggregate and then into new concrete. Recycled concrete is a good source of aggregate and has been satisfactorily used in a number of applications.
It is estimated that approximately 200 million tonnes of aggregates are used in the UK each year as construction materials, with around 57 million tonnes, or 28%, being from recycled or secondary sources; said to be one of the highest rates of the use of recycled aggregates in Europe. The Mineral Products Association states that there is "a public will to reduce the use of primary aggregates in construction" and this is done by crushing inert construction and demolition waste into new usable aggregate. The practice has become so prevalent now that it can sometimes be cheeper to source recycled aggregates rather than new aggregate in the UK. It is important than one is careful about the sources of this material; as before described for other recycled materials, it must be free from contaminants and also suitable from a strength and longevity point of view for the intended use. When using recycled aggregates for concrete or concrete block production the relevant standards for the production of those new materials still have to be met; for example the use of aggregates to make concrete is covered by BS EN 12620:2013. Limits are placed on how much recycled aggregate can be used in structural concrete and these limits do depend on the specific case.

Recycled aggregates are classified as follows:
1- Recycled Aggregate (RA)
2 - Recycled Concrete Aggregate (RCA)

The latter RCA is a specific type of recycled aggregate where the brick/masonry content is no higher than 5% and thus there is a particularly high crushed/graded concrete element. In the case of the former there may sometimes be a really high level of crushed brick. The structural performance characteristics of RCA are superior to RA and thus there are less restrictions on the use of RCA in concrete. Provision for the use of RCA in concrete is given in BS 8500-2.

A typical arrangement in the UK where a concrete frame is crushed and then converted into aggregate, is that once any reusable components from the building demolition process such as glazing, bathroom sanitary ware, floor finishes, radiators, copper pipework, demountable partitions and any recyclable materials such as gypsum, carpet and the like are removed from the building and then all of the remaining materials are demolished, crushed and sorted. This would typically involve any reinforced concrete structures, brickwork and miscellaneous items still fixed to them such as wall coverings, some plaster and so on. There are a number of stages associated with converting the concrete structures and brickwork to aggregate; crushing of the structures and then materials separation, removal of reinforcement steels and other materials, washing and separation processes for any extraneous materials such as paper, non ferrous metals, gypsum. This final part of the construction and demotion waste process happens in several steps producing materials for reuse including for scrap metals, wood and paper for recycling, brick and concrete rubble (75mm), some waste to landfill, and finally concrete aggregate of various sizes (7, 10, 20 mm).

There are certainly cases where more energy can be consumed in going through this process than in the extraction, transport and use of new aggregates and thus without doubt

government policy and wider societal sustainability drivers need to be in play for this recycling to happen. Depending on the quality of this aggregate, it can be used in a number of ways. This could include for use in; road and highway sub base; permeable landscape paving, which can be left as it is or paved over in asphalt; crushed concrete aggregate in lieu of virgin gravel in utility trenches; filling for gabions as landscape features, retaining walls; coastal protection schemes; aggregate for new concrete production.

The largest supplier of recycled aggregates in the UK is Tarmac, which is part of the CRH Group. A common use for their recycled aggregates is as road base for new highway construction, and indeed this is the most common use. CRH operates in the Netherlands a 'cycle for concrete' programme where they will take up concrete paving slabs which need replacement and then use them to make the new concrete paving slabs for the same client.

At the One Brighton development project we did extensive work in designing an advanced eco-concrete superstructure frame which led to significant embodied carbon dioxide emissions savings. This was by taking a wholly integrated approach to the design of the structure so that each element of innovation created greater leverage for the other. Firstly, the superstructure floor slabs were designed to be post tensioned which reduced both the amount of concrete (and thus also the amount of aggregate) as well as the amount of conventional steel reinforcement bar required. Secondly the Portland cement in the concrete mix was reduced by 50% to that normally required with the other necessary 50% binding element being replaced by waste material from iron and steel production; GGBS, or ground granulated blast furnace slag, which has a similar chemical make up and binding properties to Portland cement. Lastly and most pertinently we used 100% secondary aggregate. As before, the use of a post tensioned concrete superstructure reduced the quantity of secondary aggregate required which was important as this bulky material had to be transported by sea from Cornwall to Brighton's nearby port at Shoreham Harbour.
The secondary aggregate was essentially granite waste material from the production of china clay in Cornwall. Miners extract clay from granite with high pressure water which turns the material into a slurry. From there it is pumped into processing plants where it is used to create a wide range of household products including paper, rubber, paint, tooth paste, bathroom sanitary ware and the like. There are many small and strangely shaped white hills made up of this material near St Austell where these mines are located and so much so that the area has been nicknamed 'the Cornish Alps'. The hills are white from the china clay or kaolin which is mixed into the waste material. At one stage over 50% of the world's china clay was produced in this area and so huge amounts of waste product is piled up. Indeed, every tonne of usable china clay produces more than 5 tonnes of waste material. Even current clay extraction activities cover an area of 35 sq. miles, let alone the historic footprint. So this area is a huge source of material for aggregate but unfortunately, although the One Brighton development was a great exemplar of the use of this material, the trend has not taken on. The 'Cornish Alps' are now turning more of a green colour due to restoration and planting efforts and so as a result of which it seems likely that this source of waste material will remain in place and unused. The company which supplied the china clay waste aggregates to the One Brighton project, and which also produced the concrete for the project was CEMEX and they, like Tarmac/CRH, offer a wide range of recycled aggregates to the construction industry.
https://ukcsma.co.uk/what-is-ggbs/
https://www.arup.com/projects/coleman-street
https://storage.googleapis.com/www.bioregional.com/downloads/One-Brighton-Impact-Report-2014-17.pdf

Whilst the writer is not aware of any reuse of concrete structural elements as structural concrete elements in new buildings in the UK, such a use is surely feasible, albeit subject to careful thought, investigation and design. Indeed, in Finland, Huuhka et al. (2015) has proposed the reuse of over "26,000 prefabricated concrete wall panels and nearly 14,000

hollow-core slabs in Finnish 1970s mass housing". Huuhka et al consider that the concrete panels in these mass housing constructions could be reused for construction of new detached/single family housing, which now form one-third of Finnish housing. This approach would lead to reduced embodied CO2 emissions in the new constructions and well as potentially producing construction cost savings. As referred to earlier in the logistics section, however, there is the cost of handling and storage of such components to be considered given that demolition programmes and construction programmes may not coincide. If the City of Helsinki was to impose a circular economy policy requirement that new homes are made from these concrete panels as they become available then that would straight away provide a market stimulus for salvage companies or demolition companies to supply the market with these items. Financially it can work; in terms of wider economics it can only be done if the city creates the necessary policies.
https://daneshyari.com/article/preview/7495116.pdf

Meetings in Helsinki with concrete producers yielded little interest from them with regard to the supply to the Jätkäsaari project of recycled aggregates, with the providers stating that as a result of the natural geology in Finland the natural aggregates were plentiful, naturally graded and highly cost competitive to purchase. They did not perceive that recycled aggregates would be used to any great extent in Finland unless there were specific regulatory and policy incentives and drivers from government policy that would drive this.

Certainly in the UK, environmental assessment methodologies such as BREEAM give specific credits where recycled materials are used and this has been a driver in the specification and use of recycled aggregates (as well as other recycled and reused materials). There is also a cultural factor in the UK, and especially given the lack of both new landfill sites and new quarries, where from a societal perspective one prefers to see materials re-used rather than simply thrown away and wasted. This is possibly as much a population density issue; more people per sq. kilometre means new quarries and also new landfill sites are not going to be very easy to gain planning permission. Such a driver is unlikely to exist in Finland to the same degree with a much lower population density.

There are a range of design factors which need to be taken into account when using recycled aggregates and these need to be carefully studied in the context of local Finnish building codes and building regulation requirements. So experience and knowledge on the professional side with this in practice is important.

3.2 Brick

Reused bricks have been put into existing and new buildings since the Roman era; they are an obvious means of simple patch repair or of seeking for a new building to fit in to its surroundings. Why put in something new and different if you can find something matching that is closer in age and hue?

The first examples for the reuse of bricks goes back to antiquity; the Romans having left and taken their brick making secrets with them. How do you make a buildings out of bricks if you don't know how to make bricks ? Well, that's simple, you just plunder the ruins of Roman buildings for bricks. The St Augustine's Abbey in Canterbury was built in 597AD from salvaged Roman bricks. As was the church built circa 669AD by Augustine's followers inside the Reculver Roman Fort in Sandwich, as well as many others. With the exit of the Romans in 410AD the first brick building to be constructed with new bricks was almost exactly 1,000 years later in 1441; the brick built Herstmonceux Castle was constructed by brick makers from Flanders using locally available clay, and thus ended a 1,000 year period in English history when brick buildings could only be made from re-claimed and salvaged bricks and not from new ones.

One can often tell the extent of bomb damage from WW2 by the differing patina of brickwork patched in to old building facades; this era was a great spur to the reuse of bricks because of cash and resource constraints following the war. As one can imagine, a whole industry around salvaged bricks has existed in the UK for decades and, as mentioned, salvaged bricks can be more expensive and more sought after than new ones. It is not that they are better quality, in fact the opposite can often be the case, but rather that they have that unmistakable patina that can be so seductive to English sensibilities.

UK examples of brick reuse can, in parts of London or other towns and cities with large stocks of Edwardian and Victorian buildings, and most especially on the perennially under repair terraced house, be seen on almost on every street. This varies from patch repair; some done well and some not; to home or other building extensions; to indeed whole buildings although the latter is far rarer than the former.

A great divide exists, however, between brickwork that can be reused and what cannot be reused. Where lime mortar has been used to bind the bricks then they can be easily reused. But where cement based mortar has been used, then the opposite is the case; the cement mortar bond to the bricks is stronger than the bricks themselves and so attempts to separate them leads to the bricks being destroyed. Some 'green' developers now use lime mortar so that their buildings, and specifically the brickwork panels which form part of them, can be more easily dissembled and reused. It was a great shame that at the seminal BedZED development in South London the architect put forward lime mortar for this very reason. The writers recalls reading the notes from a client meeting that the extra over cost of circa £1,700 for lime mortar instead of cement mortar was considered too much for the project of 82 new homes. Information about the use of lime mortars in buildings can be found on the following web site if this of interest to further investigate for the project; www.lime-green.co.uk.

Attempts to reuse cement mortar based brickwork have succeeded where whole panels of bricks have been saw cut using diamond drills; the best example of this, though, exists in the Lendager's Resource Rows development in Copenhagen referred to earlier rather than in England. There is however a draw back to this solution as the brick panels need to be fixed onto to concrete pre-cast panels as an essential backing element and thus not quite as environmental as one would wish.
Some of the most inspiring and interesting examples of projects in England where salvaged bricks have been used are:

1 - Will Gamble Architects "a building within a building" where "two lightweight volumes could be delicately inserted within the masonry walls in order to preserve and celebrate it. A palette of honest materials was chosen both internally and externally which references the site's history and the surrounding rural context". The building has been constructed from a pallet of Cor-ten steel, oak and reused bricks; an extension essentially made out of up-cycled materials that were mainly found on site. This has allowed the building to fit into it's surroundings well. It is an effective modern intervention into an otherwise historic environment.
https://www.dezeen.com/2020/03/31/the-parchment-works-house-extension-will-gamble-architects/

2 - Bureau de Change's "Step House" is a great example of how an extension can completely reinvent a home. The extension is made out of bricks reclaimed from the same property to "create a striking stepped extension that looks like it is extruded from the main house. The staggered brickwork is also used internally, zig-zagging up the wall and across the ceiling, uniting inside and out."
https://brickarchitecture.com/projects/step-house-bureau-de-change

3 - West Street, Dover is a project previously referred to and built by my father in the 1980s. It is a small social housing development. His local building and construction business was involved in the demolition of old buildings and the construction of new ones and often using bricks and other materials salvaged from the demolition for the new construction. In this case, the previous office of the company was demolished so that the business could move to Folkestone, a bigger town, making way for new apartments and houses on the Dover site. It seemed the most natural thing to carefully take down the old structure, retain and stack the bricks, and build the new dwellings by reusing these bricks. I remember when the development was completed and thinking how interesting it looked; it fitted into its surroundings 'hand in glove' and as if it had been there for years already. There is no web reference for this project.

4 - Paul Archer Design's project was a refurbishment of a 1980s self build new home that was originally made out of reclaimed bricks from a Manchester warehouse; in part because the owners, somewhat ahead of their time, wanted to create a more environmentally friendly building. It is quite modernist for its era, when there was a strong backlash against more modern design in housing, and no doubt it gained acceptability and thus planning permission because the modernist design was created using salvaged bricks.
https://www.granddesignsmagazine.com/self-build/brick-self-build-homes/

5 - The BRE Environment Building at Garston in Watford is believed to constitute the largest modern building in the UK which reuses recycled bricks; over 80,000 of them. (The designers also used GGBS cement replacement and recycled wood blocks floors here).
https://projects.bre.co.uk/envbuild/envirbui.pdf

There are not any other known examples of larger buildings in England which have been constructed entirely from recycled bricks, although it is not unusual to find a newly constructed house in the country made entirely out of such reused bricks. These types of buildings do not typically have architectural merit, simply having been constructed that way to comply with strict planning policies which will only permit traditional designs.

Bricks can be reused for a wide array of purposes other than in new or extended buildings; in landscaping design for new garden pathways, to make garden furniture or simple decorative features, built-in BBQs (a surprisingly common feature in English gardens where they are easy to make and fire proof), garden lawn edging (my father did this), trees surrounds, fire pits, raised brick planters for flower and vegetable growing (again, something that my father built in the garden), new brickwork garden walls, seating areas etc etc; the limit of use of salvaged bricks is the limit of one's imagination. It is not uncommon in English pubs and restaurants to see interior dividing walls which are made from re-used bricks to add a certain atmosphere to the place; as it is in some newly constructed homes

The nature of some of these buildings, in particular Will Gamble Architect's "building within a building" has a dream like quality to it; and whilst one would not be so bold as to suggest this typology as something suitable for the exterior architecture of the Jätkäsaari building, it may give direction to some of the interior shared spaces and associated interior layouts/walling and how these could be designed. Certainly, this could be thought of as somewhat irrational but might just be the kind of thing that is needed for community building and community spirit; a little bit of design playfulness to encourage people to be more relaxed.

In terms of the Jätkäsaari facade, there are a wide range of creative possibilities here as well as some heavy constraints. Given the previous paper on CLT/mass timber and moisture vulnerability it would be imprudent to consider the reuse of bricks for the main facade of the apartment part of the building; unless of course they are engineering bricks of high quality and suitable for reuse. However, the architect may wish to consider a brick facade at ground

floor level only where there is more likely to be a concrete structure rather than timber; in this case there is less potential water ingress risk.

3.3 Structural steelwork and steel pipe piling casings

One of the good things about structural steelwork is that in the UK approximately 99% of it is recycled. An estimated 86% of steelwork is recycled as scrap charge for furnaces; but this is also a bad thing as that means the majority of it is not reused in the way that certainly some of it could be as structural elements. It is estimated that 13% of structural steelwork is dismantled and reused in new structures. In the recent past quite a large amount of UK demolition materials did get exported to developing countries. Indeed, demolition projects that the writer has been connected with have involved the dismantling of a coal fire power station, and also a sewage treatment plant, and their onward transport, re-construction and re-commissioning in Pakistan; in both cases involving large amounts of structural steel also being transported. Having said that there has also in the past been a relatively buoyant UK domestic market in the sale of components from previously used agricultural and industrial buildings although this has been somewhat curtailed by ever more onerous building and safety standards, increased labour costs thus making the dismantling process costly, and lower and more competitive prices for new components in lieu of old.

A good example of the comprehensive use of structural steelwork is the The Bedington Zero Energy Development (BedZED) project in London, which in many ways was a pre-cursor to the One Brighton development. The writer became involved with BedZED after the project was completed and occupied but did so meaningfully in carrying out some viability, cost and environmental evaluation studies to establish its potential for replicability as a development model. BedZED is a mixed-use housing and office workspace sustainable development community which is one of the seminal green development projects of its era. The development comprises 82 homes, 18 live/work units and 8,500 m2 of office workspace with a community centre building. The structural system is load-bearing masonry with structural steel being required mainly in the office areas. The project team wanted to show that salvaged structural steel could be used for a project of this scale. A further requirement was that the steel should be sourced from within a 50km radius of the development. Of the total requirement of 100 tonnes of structural steel, 95% was sourced through salvage. Structural steel members from a Brighton Railway Station refurbishment works project were found which were in suitable condition for reuse and these made up 80% of the structural steelwork requirement. This steelwork was chosen based on the engineers calculations and steel section sizes and thus no change to the structural design was required. The structural engineers inspected the proposed steelwork (which comprised two other suitable sources at other salvage yards) and established their age/date of manufacture, condition and suitability for reuse and indeed re-fabrication that was required as regards connections. It was convenient that all of the salvaged steelwork members were from standard sections and thus from historical records the structural performance of these members and their suitability for reuse in the project could be ascertained. The salvaged steelwork was in such good condition that little work other than re-painting was required. A number of lessons were learned from this exercise, thought to be the most ambitious of its kind to date:

- A strong commitment from the client, design and construction team is required to ensure that this can happen; otherwise simple hurdles can prevent this.
- It is important that the decision to use salvaged structural steelwork is made right at the start of the project as this gives the necessary additional time required to evaluate and assess what is available. This should include early outline design of the required steel structural sections as regards approximate lengths, grade of steel and section sizes, so that it is clear what is being looked for.
- However, if steel members are available which do not meet the above requirements fully then it is helpful that the structural engineer and indeed also the architect are flexible and

adaptive in their designs to what might be available, albeit within the limits of practicability.

- Whilst storage and timing issues are often cited as problems, the salvage yards where the steelwork was stored were in fact happy to maintain storage of them until the construction programme scheduled date for delivery; thus highlighting the need for good relations and communications with the salvage companies.
- There needs to be some flexibility in the construction contract around this aspect of the project in order that the contractor cannot make a claim under the contract if there are changes. Open and honest dealing on all sides is important. The requirement for the incorporation of salvaged materials should be written into the construction contract so that the contractor is bound by this and is made aware of it. To reiterate, it is important that the contractors when tendering for the project are briefed on these kind of differences from the outset so that they know what they are getting into. This approach is unusual and is helped when it gains the enthusiasm and trust of contractors.

This approach at BedZED, which was undertaken now over 20 years ago, was a little on the informal side and the team were fortunate to find what they wanted without undue effort. The engineer certified the steel work as suitable for use in a way that an engineer may be less inclined to do in todays more anxious and risk prone environment. It is therefore recommended that the following document is reviewed which takes the reader though a more rigorous process as regards what should be thought about with regard to the re-used of salvaged steelwork and this approach is likely to be more in keeping with what one would expect to do today:
" Protocol for Re-using Structural Steel "
SCI (Structural Steel Institute) Knowledge
https://www.steel-sci.com/assets/downloads/steel-reuse-protocol-v06.pdf

This document was published in May 2019. Note that it is not now recommended by SCI that any steel produced before 1970 is reused in the UK and this will somewhat reduce the scope of what is available; the reason given for this is that it is assumed than any steelwork made after 1970 " meets the properties assumed in manufacturing Standards such as EN 10025" and thus, by implication, than any steel made before 1970 does not meet EN 10025. Whether or not this cut off date vis a vis acceptability would be applied in Helsinki depends on the structural engineer, city engineer/building control officer etc; but one way around this would be to carry out some strength tests as suggested. Another way around it could be to limit the lengths/span of steelwork used so that risk factors are very considerable reduced.

There is volatility in the price of steel and this can feed into price of structural steelwork. However, what we have found in the UK is that the price of scrap or reused steel quite naturally follows the trend so that the salvage yards can be quick to put up the price of salvaged steel if the price of new steel escalates.

The CIAC (community in a Cube) sustainable community development in Middlesbrough, completed in 2012, comprises 80 apartments and commercial and community space. The foundations for the development used recycled steel casings from the UK North Sea oil industry. Wholesale decommissioning of oil rigs and platforms is leading to the bringing back on shore of very large volumes of steelwork and other materials. There are significant quantities of this material available in Europe and a market has also emerged for this sector in the US. It would seem likely that the Norwegians are also undertaking a similar exercise and thus it is possible that this material could be available cost effectively in Helsinki. Again, this example reiterates the need for early consideration in the design process of what materials could be from salvaged sources. The CIAC project was conveniently located near to the recycled steel casings supplier and it was by chance at the time that the design team became aware of this possibility and that we could reuse them. It would seem likely that the ground conditions on the site of the CIAC building (the former dockyard area of

Middlesbrough) could be somewhat similar to the ground conditions found at Jätkäsaari thus necessitating for the latter the use of piled foundations.
More information on this approach in general and the benefits can be found on:
https://www.geplus.co.uk/news/report-on-carbon-savings-from-repurposed-steel-tubulars-18-01-2021/

At the Jätkäsaari project there are a number of areas of potential use for salvaged structural steelwork and these include: internal door lintels, steel structures forming part of non load bearing partition walls in the large open shared spaces area (it is assumed that at first floor level there would be a concrete floor slab acting as a structural transfer deck); steel framing in the basement storage area; secondary structural steelwork support for areas of the CLT structure to enable reduced CLT slab thickness (possibly in the roof structure), as well as the use of recycled steel pipe casings for any possible piled foundations

More information about structural steel reuse and recycling can be found as follows:
https://steel-sci.com/assets/downloads/structural-steel-reuse/161130-bcsa-cullen%20002.pdf

3.4 Structural timber

The previous sections in dealing with concrete, aggregates, brick and steelwork address building materials which can be of high durability, consistency and reliability of performance. In considering the reuse of structural timber, or indeed timber of any form, one is dealing with an entirely different material. Timber is not durable, certainly softwood timber is not; it can easily get contaminated with mould and/or decay fungi, painted over with lead or other harmful surface finishes, it can be split and even already subject, in part or fully, to rot. Notches may have been cut into it which have undermined its structural integrity from day one and it may also be full of nails and indeed damaged from nailing and de-nailing as well as the simple scuffing and abrasion brought about by every day use. It is no surprise then that very small amounts of timber ends up getting reused with much of it being incinerated as biomass for heat and power generation and even this latter use is not always straightforward given potential contaminants in the timber.

Having said all of that, the writer once met a single family house builder in North Carolina, in the US, a psychologically damaged Vietnam vet whose family had a big land holding and housing development rights. This developer used to ask the local builders and contractors to drop their construction waste, often largely timber sections, at the bottom of the family's land in great piles. In his semi stupefied mental condition (he had been a US Air Force pilot shot down and kept prisoner by the Vietcong for years) he would scour through this material over many months and piece together timbers of similar lengths and section sizes; one could see that this was for him a kind of meditative and healing process. Once he had got enough of them to make a house he would then lay the timbers out on the ground as in the style of a drawn up floor plan; one layout for the ground floor and another for the first floor. He would build the house using those layouts kept firmly in this mind; the homes were made from the timber sections and all sorts of other salvaged materials. The houses were astonishingly beautiful, simple and natural. I recall him feeling awkward about the proportions of one of the first floor bedrooms. He said; " I know it's a funny shaped room, but I had a rake of those short two by six timbers and so it just had to be a long and very narrow room " He made one of those houses for sale every two years and that was his livelihood.

At the One Brighton development we did a lot of work to assess the viability of using timber for the interior partitions and decided that the extra over cost of circa £300k to the project (across 172 apartments) was not worth it on value or environmental terms. Whilst salvaged timber was used in the construction of interior partitions at BedZED it was unclear that

there was much benefit as a result; the costs involved ended up being higher than had been estimated at the start.

So this is a material which one must approach with caution from a re-use perspective. Indeed, it may seem somewhat perverse in a country such as Finland with abundant timber resources to even consider it. At the same time one could argue that Finland should direct it's timber resources for the export market and seek to retain and reuse as much of its existing stock of timber in the buildings as it can; and most certainly if it is to meet domestic and EU targets on reuse and those emerging around circular economy.

So what examples can we find from the UK which may be of some use and relevance to Jätkäsaari ? The writer has been in conversations where thought has been given to the use through re-processing of salvaged softwood to create new CLT materials; at present this is simply a discussion and certainly a big challenge is the amount of re-working of the softwood before it is ready to be made into CLT; likely far more cost and complication than new softwood.

The majority of structural timber that is reused in the UK is oak; so a durable hardwood species. A quintessentially English use for re-claimed oak is in the refurbishment of the many medieval and later era barns and farm buildings. There is a whole industry in people converting these sometimes abandoned buildings into new dwellings with both the original oak timbers and indeed the newly reclaimed ones being proudly on display throughout the new homes.

3.5 Timber cladding

Timber cladding can have similar frailties to those set out above for structural timber, although a higher proportion of good quality external timber cladding is hardwood rather than softwood. However, as this is for use as a finished material (unlike most structural timber) one can see the attraction that it may have from its inherent patina. Timber cladding is one of the most desirable external cladding materials for new suburban homes and in part because it conveys a more modern and slick appearance and but also quite simply because it is not brick. There are essentially two main forms of timber cladding in England; painted or treated softwood or hardwood, mainly Western Red cedar; the latter seemingly has the same level of market credibility and recognition in housing as BMW has in cars. Western red cedar is still relatively new as a material having become more widespread at the turn of the millennium and is not thus entering at present the re-use market in any great numbers; although the removal of much of the timber cladding fixed to apartment buildings over 18m and now 11m tall in the wake of the Grenfell fire enquiry and subsequent government dic tac on the banning of flammable materials in external building facades and balconies may create a market for re-use in lower rise housing or elsewhere. Softwood cladding would not typically get re-used unless there was something particularly interesting and attractive about it. Given the vulnerability of the proposed CLT at Jätkäsaari it would be impractical to suggest the use of salvaged timber cladding for the exterior facade; apart from anything else technically challenging and risky, it would no doubt be very costly as well. In the main then timber gets re-used in the interior of buildings as a decorative interior wall cladding rather than, typically, an exterior wall cladding. From an interior use perspective there are many attractive examples of the use of wood both as wall cladding and as a decorative feature more generally; most especially in the manufacture of new furniture. In fact right now the interior design magazines and the internet are pretty much on fire with excitement over the potential for salvaged timber as part of this 'distressed look' that is so often sought out. The writer chose to stay in a newly established hotel for business purposes some months ago in Brighton and the walls of the rooms were adorned with some gorgeous wall and ceiling cladding which gave warmth and character to the whole building; the whole done with an impeccably good interior design eye for detail and composition. One of the emerging

features of this trend is to also cite the provenance of the reclaimed timber; one advert proclaiming that you can:
" Benefit from the fun and character of wall or floor maple cladding reclaimed from the old McVitie's Factory " adding some (presumably) witty and meaningful spice to the aching beauty that is already there.
So in terms of Jätkäsaari there is a huge opportunity to think about using reclaimed and salvaged timber as the interior design/wall cladding finish for parts of the building. It would certainly give warmth and character to the place as well as acting as a high profile every day reminder to the residents that old materials can be found a new and useful place in new buildings and most especially in new housing developments. Clearly fire regulations will require fire resistant coatings or other treatments to this timber so that it can resist and not contribute to the spread of fire and this will need to be thought about in the context of local regulations.
For more information on wood recycling please see the following:
https://lawsonsyard.co.uk/collections/wall-cladding
https://boisantique.co.uk

3.6 Floor finishes

This is big market in the UK for salvaged materials. Old wood, often more expensive and more appealing than new, continues to have virtual star dome levels of appeal and especially in the housing and hospitality sectors. People in England are also discovering their own inner floor boards; in the last 20 years probably hundreds of square miles of carpeting has been torn up and thrown out, to reveal often beautiful, warm and characterful pine or other floor boards that have been there for over 100 years. Wall to wall carpets are out, and floor boards with rugs are back and so this has set the trend for the reuse of old timber as a floor finish much more widely.

On the web there is a good choice of almost every type and species of timber being made available for sale as flooring; oak, pine, longleaf pine, Douglas fir, redwood are the most common hardwood species.
However, there is a wider market in the UK for reclaimed flooring materials beyond wood flooring.

Linoleum is a particularly popular flooring material as part of urban chic. Although it was eclipsed by vinyl in the past, it has now experienced a little come back; both in terms of newly made material and also as salvaged material. Its main constituent is natural linseed oil derived from flax (and not chlorinated petrochemicals as for vinyl) and thus it has become somewhat of a cult sustainable material. It lasts between 25-40 years, can easily be recycled, is biodegradable and it does not contain any harmful substances. Pre-WW2 vintage linoleum patterned 'rugs' can sell for many thousands of pounds such is their cult status. Whether it has any cultural or historical context in Finland will no doubt drive or hinder any interest in its possible use.

Another "come-back-kid" green material is cork, a naturally occurring and renewable resource which is harvested from the cork oak tree. This was a popular material for both wall and floor finishes in English housing in the 1970s in particular, but by the 1990s was out of fashion. Cork has a cellular structure which provides it with good insulation. It also has good sound absorption qualities which can be particularly useful when used as flooring in apartment buildings. It is manufactured into tile or sheet form from previously used wine corks as well as the waste material from the manufacture of cork products. It can produce a particularly pleasant feeling in a room with a relaxing feeling coming from its natural resin as well as the soft acoustics that it engenders.

There is some fashion for the use of stone materials re-made as flooring. These materials are often quite expensive and generally used in more expensive homes given the expense. Salvaged and re-used ceramic floor tiles can be popular given their often colourful patterns although they generally seem to get more use in the hospitality trade where their stylistic and colour vibrancy is more in keeping than with normal every day domestic use. Certainly this can appeal to the more avant-garde person!

Please refer to the following web sites for further reference;
https://www.reclaimedflooringco.com
https://www.forbo.com/flooring/en-uk/commercial-products/marmoleum/c0aq3g#panel_101
https://spduk.co.uk/pages/what-is-cork
https://www.renovategreen.co.uk/interiors/how-to-make-your-tiling-project-eco-friendly/
https://www.yorkstonedirect.co.uk/natural-yorkstone/?utm_campaign=Reclaimed+Yorkstone&utm_source=google&utm_medium=ppc&utm_term=reclaimed%20stone&utm_content=2077300xCj0KCQjwm9yJBhDTARIsABKIcGao31d74wGaUGWzNg77EC18ceTKGwxCSLCq79LkS6pS-CNMhr56hBkaAvfNEALw_wcB

4. Examples of waste avoidance strategies in the UK

4.1 What is waste ?

This is a simple question but with a complicated answer; in the main, legally complicated by virtue of complicated regulations and also, in the UK, case law. The reason is that waste is a wider societal problem. A habitual nuisance is the English country scene were some illegal waste dumping has happened in an otherwise beautiful village and the angry neighbours get the local authority at considerable cost to remove the waste to a licensed dump; or the simple event of a pollution leak from a factory, illegal in the main as well. To control waste legally it has to be legally defined. To some extent, European regulations do still apply in the UK. In accordance with EU Waste Framework Directive (WFD) 2018 amended by the EU Waste (Circular Economy)(Amendment) Regulations 2020; and then again by The Waste and Environmental Permitting (Legislative Functions and Amendments) (EU Exit) Regulations 2020 setting out "how articles 5 and 6 of the WFD should be read now that the transition period has ended"; the legal definition of waste remains in the UK the same as it is in the EU, per Article 3(1) WFD which states that:

" 'Waste 'means any substance or object which the holder discards or intends or is required to discard."

In the UK "discard" has always been considered to be what happens to any surplus materials produced during the construction process, i.e. is it waste. As a result the producer of the construction waste, i.e the "waste producer"; the construction company or the developer if it is also a construction company, has a legal duty of care in connection with the management of waste; this is in reality somewhat discharged by the contractor making sure that the waste contractor, or "waste carrier", who collects the waste promises to continue to manage it in accordance with his or her duty of care obligations per a completed "waste transfer note". This assumes that the contractor has been honest about what the material actually is. However, recent guidance published by the UK government for England now gives, on the basis of the amendments referred to above, some considerable new complications to what is defined as waste. The objective of these amendments is to narrow down and reduce what is defined as waste so that it is easier to reuse surplus or unused materials arising from, for example, the process of construction.

The first obligation now is that : "You must try to prevent and minimise the production of waste as much as possible. " Accordingly, the new guidance states that:

"You should work out if your material:

- is waste – it meets the 'discard 'test
- was never waste – it meets the 'by-product 'or 'reuse 'test
- has stopped being waste – it meets the 'end of waste 'test"

There are a number of stages in the proof of whether the surplus material has been discarded or not and thus whether it is to be classified as waste or not; These tests include, inter alia, the following;

- " Certainty of use: The holder must be certain the material will be used " If one is in the business of re-use then one is certain about that; in which case it is not waste.
- "Fit for purpose: If a material cannot be used in the way it is meant to be, or it does not meet relevant standards "-in which case the contrary applies; if "fit for purpose" can be shown to apply then it is not waste; with regards to relevant standards; the standards would apply to the material as it would have been delivered to site in the first place on the basis that it met standards (if it was not old, salvaged etc).

- "Specific purpose: If a holder's material has no specific purpose it is…[essentially waste]". Again, the contrary applies; if it has a specific purpose, i.e reuse, which can be demonstrated, then it is not waste.
- " Return for a refund: The holder of a material they return for a refund has a value, so is unlikely to have been discarded. " in the view of the writer this is decisive; if the contractor arranges as part of his or her commercial agreement that the supplier will pay as a refund for any unused materials then the materials are not discarded as waste. A pricing structure could be arranged to accommodate this.

Whilst "by-product" criteria will not be looked at here; there is now also a "reuse" test for materials which applies:
"When a material has not become waste; Reuse means a material will be used for the same purpose for which it was designed.
" The Environment Agency may consider a material for reuse as non-waste unless:
- its use has become illegal
- it is a subordinate use or incidental to it
- it requires waste treatment before reuse"

Again this would enable much surplus material arising from any construction site to be reused as non waste.
There is also criteria to establish at what point any waste that has been re-processed is no longer waste:
" When a material meets the end of waste test: Waste substances or objects must have been through a recycling or recovery operation to be classed as non-waste. This is providing they meet all the conditions of the end of waste test. Once they are classed as non-waste, waste controls do not apply to these substances or objects.If a material is taken out of one building and placed in another for the same use then it is not treated as waste in the UK. It would also seem that if the material is re-processed in some way then the same logic would apply; at no point has it been discarded. "

The use of suitable protocols for the re-making of these materials into new construction products are recognised so that once any work is completed in accordance with the protocol then the new material is no longer classified as waste at the stage.

It should be made clear that in the UK if a material is taken out of one building and then placed into another to perform the same function as before then it has not, historically (i.e since 1990) been classified as waste.

In overall terms then the range and scope of materials that are classified as waste are now, as one would hope and expect, reducing in light of moves towards a circular economy and this itself is going to open up great opportunities for the reuse of materials that would otherwise possibly go to waste.

4.2 Examples of waste avoidance strategies

We are addressing the Jätkäsaari project as a new build development on a cleared site where there are no salvaged or reusable building materials available which were on a previous building on or near the site. How are we to avoid, or at least reduce, any waste that may arise as a result of the construction process ?

The first point to address here is the at times quite widespread presumption that site based construction produces far more construction waste than is produced when buildings are made in factories. The same amounts of materials are required in both cases. If the designs lead to the use of large areas of plasterboard than will ultimately get fixed to the walls, then

in both cases an amount of waste plasterboard will be produced. Similarly, if standard timber lengths have to be cut to the length required to suit a specific purpose, then the same amount of waste, again, is produced.

DESIGN APPROACH and MATERIALS SCHEDULING

Site based construction when done badly, indeed just like its factory cousin, can be wasteful. The origin of this, and this is the first aspect of construction waste avoidance, is the poor and inaccurate scheduling of materials. Materials scheduling is quite a skilled job, albeit under rated no doubt; it requires the scheduler to understand both technical specifications, technical drawings and also the process of construction. When people are not skilled at this job then, whether in a factory or on site, they will tend to over order the number of materials that are actually required and this is what can lead to waste. They will do this because one of their biggest fears is that the construction workers will run out of materials; so best to over order to avoid this. Another factor can be theft from construction sites of materials and most especially if they are left laying around. The next part of materials scheduling is in many ways a moot point. Some will say that materials wastage is the fault of the architect. If only they could design rooms of specific dimensions so that only full sheets of plasterboard, and not cut lengths of plasterboard, are required. The reality is that there are many factors which drive the length, widths and heights of rooms and it is impractical to suggest that all of these should be subordinated to the somewhat arbitrary dimensions of plasterboard that comes from the factory. Plasterboard waste will inevitably occur and the issue is what to do with it, and how to minimise the amount of waste. A value engineering approach, which unfortunately has a bad name as another cynical term for 'cost cutting' is in fact a valid and really useful way to consider materials and resource efficiency. There are two factors at play here; firstly to consider how a specific building performance, or other functional or aesthetic requirement can be met with the minimum level of resources. There are several angles to this. For example the structural engineer may have assessed the structural dynamics of a building in such a way that larger section seizes for materials are required than is the case; it can be clear sometimes which engineer is more confident in their analysis. A more cautious engineer can sometimes substantially over engineer a structure and this can have huge implications from the amount of foundation material required all the way up through the building to the roof structure. So "lean design" thinking is an important approach and skill to be deployed. (It is important with CLT though to not over engineer the design and one must think about where reduced CLT thicknesses can be applied and even where CLT can be avoided. In the CLT paper there was thought given to the use of conventional timber joists and marine ply to form the bathroom floors and whilst this addresses significant moisture risks it also addresses resource efficiency and waste avoidance; CLT in very short span spaces is not always the most efficient use of the material.). Another factor at play can be the use of decorative materials which can be quite involving. Is there another way of meeting the need for something stimulating and interesting? Perhaps an approach to colour and pattern rather than complicated finishes? Secondly one can consider whole life costing issues. There may be a higher level of capital cost associated with a heating and hot water system which is more efficient over the long run that the lower capital cost version and in which case it would make more sense to spend more money up front. Similarly, the choice of materials for the building should be done with the ongoing maintenance and management costs of the building in mind. It would make more sense to use more expensive materials if over the long run there will be an overall reduction in the cost of maintaining the building.

QUALITY CONSTRUCTION MANAGEMENT IS NECESSARY FOR GOOD QUALITY BUILDING and LESS WASTE

A really core factor in the ability of the site based construction manager is his or her ability, at all times working closely in concert with the building trades foremen etc., is to correctly sequence the construction work. One of the biggest drivers of unnecessary waste is poor work sequencing and lack of co-ordination.

A good construction manager will carefully think about and design all of the aspects of and need for temporary construction works, in the same way that one might design a permanent

building. One of the reasons why sometimes larger amounts of construction waste are generated can simply be that the construction site is badly managed, poorly designed and chaotic. Building workers work well in clean, efficient and carefully designed environments, just like anybody doing their job in a factory, or any other workplace environment. The construction manager must think about the work faces that open up as the construction project progresses and how to ensure that these work areas are kept clear, clean and safe (with good access, lighting, edge protection, signage). This should also include the provision of good quality accommodation for the construction workers; rest rooms, drying rooms for clothes, areas for eating and socialising. It is important that there are construction labourers on site who keep the place clean and tidy and this includes the toilet and any shower areas; if these areas are unpleasant then how can one possibly expect for good quality construction to occur ? Tidy, tidy, tidy; clean; clean, clean. Construction workers who feel disrespected and thus demoralised will not produce good quality work and materials wastage will go up. It is simple psychology; why should they care about what you need if you do not care about what they need? All of these things are clearly interconnected and this is not about a misplaced altruism. Bad work environments are a resource efficiency and productivity disaster.

CONSTRUCTION WASTE MANAGEMENT PLAN (CWMP) AND REPORTING

It is similarly important that the consecution waste management system as a part of the temporary works of construction is carefully and thoughtfully designed. This should be fully integrated into the building as any waste management system would be so that it is easy and convenient to use. There should be allowance for simple waste segregation which addresses how this is done in Helsinki. It is important that data is kept on each of the waste streams; how much of each is produced on a weekly basis and that this data then forms part of the monthly reporting for the project. There is an old adage; if you can't measure it then you can't manage it. These waste streams will tell a number of stories about what is going on. CLT buildings which are built using on-site and not off site construction can have extremely low levels of construction waste and this is inherent to this type of construction. The panels come to site exactly the right size and shape, with apertures for doors, windows, service access already cut through them. A CLT panel can replace what in a more conventional building would comprise a whole range of heavy building materials. A good tool to think about using for the CWMP plan is the BRE Smart Waste system if this, or an alternative system, does not already exist. This system has been in use in the UK construction industry for over 15 years (the writer first used it in 2003) and it has the largest market share of any systems. This system enables benchmarking of the construction waste outputs from the project against similar projects in the UK and elsewhere and this networking element can be helpful in driving continuous improvement on the project. The last place any construction waste should end up in is the landfill site and local scrap and recycling companies should be contacted who will take back waste. In the UK British Gypsum have for years been taking back plasterboard waste from construction sites which they reprocess back into new plasterboard, claiming that this essentially closed loop manufacturing process is now cheeper than sending the waste plasterboard to landfill. Suppliers who have such take back schemes should be encouraged and indeed, those who currently don't have such schemes should be encouraged to start them. Reporting on the CWMP should form part of the contractors report to the client and this should also feature in the weekly co-ordination meetings with suppliers and subcontractors so that there is a good awareness and understanding of the issue; data from the CWMP is a good proxy for the efficiency of the subcontractor. The main contractor could be encouraged to minimise the amount of cardboard waste from deliveries and could use a compactor on the site for this waste stream. The Jätkäsaari project could reach out to the other contractors at the development and if they are not doing it already, encourage them to take on and implement similar CWMP practises.

5. Suggested guidelines for the reuse of materials in building projects in Jätkäsaari, Helsinki

5.1 List of guidelines

1 - Go out to the salvage and recycling companies in Helsinki and the wider metropolitan areas and see what types of materials and stock levels they already have available; there may be some surprising finds and also some imaginative leaps that result from this process. The market in reuse and salvage materials is not a new exercise and there will be organisations with deep pools of experience from the established practitioners and who will have already gone into the possibilities and potential of circular economy. To get the most out of this process allocate something like 1 or 2 full days for this and go as a limited project team; this exercise is always better with more than one person and also with a range of professional disciplines who will all have different perspectives, experiences and interests on what is available and on what is possible.

2 - Schedule out what demolition projects are underway and planned for the project time interval and establish what materials could be yielded from such projects after making enquiries. Undertake this scoping exercise in concert with the City of Helsinki planners who will be able to give further insight and information. Other residential buildings, most especially hotels, but also educational, civil and governmental buildings may all be rich sources of suitable materials; the latter two building types (depending on the era constructed) may have been constructed from particularly high quality and durable materials.

3 - Arrange for some early concept and design work where the architect and project structural engineer can identify potential quantities of materials required and associated building performance specifications. This will then inform the above exercises (1) and (2). In both cases it would be helpful to keep an open mind on what could be reused but at the same time it is good to have some objectives to aim at. One should not push the specifications too hard; if an attractive material at the right place and the right time comes along but it is going to require quite a lot of work, design effort to bring it up to specification then don't worry about turning it down. The process must remain a largely rational and objective one mindful of project constraints. Try to approach resistance to the use of materials from a technical and scientific basis as this gives firmer ground for argument; there can be negative and even irrational emotions in some people associated with older materials and who might believe them to be substandard and inappropriate for a new apartment project; let the science and technology speak out. Craft a quality management plan for the reuse of salvaged materials and base this on relevant protocols and standards that are available; the UK SCI protocol for steel reuse is a good example of what can be done.

4 - Set an allowance in the project budget for the extra over costs of this process. This should include any additional design and specification works (over and above a new build apartment development), as well as any additional costs associated with the surveying/investigation of materials, storage, re-working/re-making, including the use of technical and research services of specialists such as, for example, VTT. Consider where there may also be additional costs in the construction contract as a result of this approach and think carefully with the construction lawyers (whether standard or bespoke forms of construction contract are proposed) with regard to relevant contract clauses and contract conditions

5 - Tackle the potential barriers and hurdles to the use of salvaged materials early on with key members of the project team; clearly the design and professional team need to be brought on board early; and careful to make sure one avoid deep sceptics getting into the team (this

approach does after all involve hard work and diligence); as they could spoil the party. Healthy debate is good; obstructive cynicism is not. An approach such as this needs a strongly led, confident and positive approach with that person needing to be suitably technically literate. Arrange for a briefing seminar or seminars where the concept and project goals are put across clearly to all. Get the support of organisations like the City of Helsinki, ARA, building control specialists, building warranty company. A problem area which may occur in Finland is the requirement for CE marking of construction products; this has not been a barrier in the UK but may be elsewhere. Make sure that the construction companies who are tendering for the project understand what is involved and get on board with the ethos of the project; sell to them how it may help them with winning business in the future as circular economy drivers increase. It is recommended that an all-parties workshop is arranged early on to co-ordinate between the various interests and also to grind out any show stopper problems or challenges, and how these can be overcome, early on.

6 - Given the easy vulnerability of the proposed CLT/mass timber superstructure to moisture damage it does not make sense to reuse materials for the main apartment elements of the facade where careful design detailing and good quality workmanship is required to keep the structure dry; unless some very consistently high quality engineering bricks can be located (which could be salvaged from an infrastructure building or installation). However, the proposed concrete framed basement and ground floor are less risky areas and more widely available stock bricks could be suitable as a facing brick for the ground floor exterior and also for use in the basement areas.

7 - For the ground floor shared spaces salvaged wood flooring could be used to give a warm and high quality feeling to this area; perhaps different colours and patterns of wood flooring from different buildings could create something which is particularly interesting and vibrant. There may also be the opportunity to use wood panelling/wall cladding in the ground floor areas; although thought would need to be given to both acoustic and also fire resistance requirements should this be the case. If there is still the idea of a shared communal kitchen, then there may be a good market in Finland already for such secondhand equipment and associated materials as it is generally in stainless steel. Restaurant chains, hotels and even schools and colleges will upgrade their kitchens.

8 - There may be good opportunities for the reuse of structural steelwork in a number of parts of the building; the basement areas as partitioning for storage areas; as secondary support wind post steelwork for any brickwork, block work or cladding that may be used at ground floor level; door lintels for internal ground floor partitions; secondary support steelwork in the roof space to help to reduce depths of CLT slabs and also perhaps to facilitate more dynamic architecture.

9 - In all cases record the history and story of where the salvaged materials are from; what building and where it was located. People can find this fascinating and it can trigger one's imagination to think about the old buildings from where these materials were sourced; which people used to go there and to do what; perhaps some relatives used to go there even; did children grow up knowing/being familiar with those materials? One of the challenges that people have when old buildings are demolished is the loss of memory that those buildings in the past might have triggered and the somehow protected; so these old materials can also be a repository of memories for some. A little brochure could be assembled which then brings all of these stories together and this may stimulate the imagination of people; adults and children alike and make the need development seem more interesting and lively.

10 - Put together a good and comprehensive Construction Waste Management Plan (CWMP) and collect the data for the various waste streams for this as a reporting exercise. Consider what digital systems are available. Take the opportunity if this is not already done to share the data in a network and use this to reduce down waste streams as far as possible. Consider setting up a materials exchange with contractors.

11 - Try hard to recruit the best quality people for the project team. A dedicated reuse/salvaged materials co-ordinator would be a good and focussed resource to get the job done well; there may be some funding for a role such as this; indeed, there may be a person available from the salvaged materials field who could fit into the process especially well. The level of hard work and innovation for a project of this type can be testing for any team and so competency and dedicated resource can be the critical success factor for the project. Do remember that the construction management systems and approach for the project needs to be at an especially high level of competency to be able to cope with the reuse of materials as well.

12 - Although this project by its nature as part of the Kehittyvä Kerrostalo (Emerging Apartment Building) Programme is a pilot and demonstration project, seek to embed it strategically into the ambitions and work programme of the City of Helsinki with regards to circular economy so that a strong mutual synergy is created; the city gets a project that can help to catalyse and give added impetus to circular economy and the project hopefully gets more resources and backing where it is needed to do this job as well as possible.