Note of SAFESPUR Meeting

Re-use and recycling of crushed concrete aggregate

NISP (SKM Enviros), Salford Quays, Manchester, 3 April 2012

This meeting was held to discuss opportunities and challenges in the re-use and recycling of crushed concrete aggregate arising at nuclear and defence sites. There were about 45 participants, who came from contractors and consultants, nuclear sites, regulators and universities. It was chaired by Paul Atyeo from Research Sites Restoration Ltd (RSRL), Harwell.

The meeting began with short presentations that provided:

- an overview of re-use and recycling of concrete from nuclear sites, including forecast arisings
- examples of current practices in the nuclear sector
- a summary of what is being achieved in other sectors
- a regulatory perspective
- a case study illustrating public attitudes to off-site use of concrete produced by decommissioning a defence site.

In a first for SAFESPUR, the presentations were video recorded so that they could be viewed on the website. The presentations were followed by a discussion of barriers to re-use and recycling of crushed concrete aggregate from nuclear and defence sites, and how these barriers are being, or could be, overcome.

Overview and Forecasts of Arisings

This first presentation was given by David Rossiter, Head of National Programme at LLWR Ltd. He said that crushed concrete aggregate arising from nuclear and defence sites can be divided into four categories:

- low level waste (LLW)
- low activity LLW (LALLW, with activity less than about 200 Bq/g)
- very low level waste (VLLW)
- non-radioactive (ie with activity levels below those in the legal definition of radioactive waste[1]).

Interest in re-use and recycling of all these categories of material has been increasing since the publication in 2007 of the Government LLW policy, with its emphasis on the waste hierarchy. The opportunities and challenges of re-use and recycling were recognised in developing the UK Nuclear Industry LLW Strategy, which aims to reduce the volumes of waste produced, increase the amounts re-used or recycled, and find routes for LALLW and VLLW other than disposal to the Low Level Waste Repository (LLWR).

The 2010 UK Radioactive Waste Inventory includes 4.4 million cubic metres of raw LLW, of which about 45% is soil and rubble. It had been forecast that about 85% of VLLW arisings, some 3 million cubic metres, would be soil and rubble. However, the Nuclear Decommissioning Authority (NDA) and LLWR Ltd are carrying out work to improve estimates of arisings of LLW, LALLW and VLLW. Studies for Sellafield and Magnox are showing that as much as 50% of what was previously thought to be VLLW might be non-radioactive.

[1] This category would have been referred to as “exempt” before the legal definition of radioactive waste was changed in 2011.

LLWR Ltd is investigating the re-use of VLLW crushed concrete aggregate in the profile layer of the cap that it plans to build over the parts of the LLWR where disposals have ceased. It has shown that the cap profile might accommodate 200,000 – 700,000 cubic metres of VLLW. This would lead to a significant cost saving and avoid the need to transport clean profiling material to the site. Further technical work is being carried out in 2012 and there will be discussions with stakeholders. LLWR is evaluating the impact of using VLLW on the Environmental Safety Case (ESC), which the Environment Agency is currently assessing. The Agency will decide in 2013 whether it will accept the ESC and issue an environmental permit for further disposals of LLW at the LLWR.

Examples of current nuclear sector practices

Sellafield

David Adamson of Sellafield Ltd said it is estimated that about 2 million cubic metres of waste concrete will be produced from decommissioning the whole Sellafield site and most of this will be non-radioactive. There are a number of options for on-site re-use, including for hard standing and landscaping for new projects and to infill voids such as the basins left when the Calder Hall cooling towers were demolished. The National Nuclear Laboratory (NNL) is also studying the possible use of finely crushed recycled concrete in the tops of drums of cemented intermediate level waste (ILW). Recycled concrete cannot be used in high-specification concretes for safety-related parts of new facilities, or for shielding.

Sellafield Ltd uses BS8500-2 as its quality standard for concrete re-use. Care is required over chloride content because of the coastal location of the Sellafield site. Issues that have arisen in planning re-use of crushed concrete include quality and testing, contractor responsibility and whether the supply of recycled material can be matched to the rate of building of new facilities on the site. At present there are no plans for sending concrete offsite for re-use.

Bradwell

Ellanor Joyce of Areva-RMC summarised the situation at Bradwell, where she is seconded to Magnox Ltd and works in the waste management department. The site is carrying out an accelerated decommissioning programme, which will lead to the care and maintenance phase starting in 2015. It has a concrete re-use strategy that covers both the generation of waste concrete and its re-use. Any concrete that is hazardous waste is sent offsite for disposal, as is concrete that is non-hazardous waste. Concrete that would be inert waste is re-used onsite.

In the past Bradwell has used the WRAP[2] Quality Protocol as the standard for concrete re-use. It is now changing to using the CL:AIRE[3] Code of Practice, which has the advantage that it involves standards tailored to the needs of a specific site and project. This is important for Bradwell, where much of the concrete it wishes to re-use has relatively high chloride levels but is suitable for applications such as construction of roads and of the base of the ILW store. Assessment of suitability for re-use involves chemical risk assessment and engineering assessment of the end use. Crushing is carried out by a mobile plant, which is brought on to site when enough material has been accumulated. A project waste management process is used for the whole operation, from characterisation through to end use, with good records management.

[2] Waste and Resources Action Programme – see later presentation.
[3] Contaminated Land: Applications in Real Environments.

The advantages of the re-use strategy include saving money, reducing the carbon footprint of the site and reducing shipments of waste and of new material. Challenges include finding the space for stockpiling of concrete prior to crushing, specifying project requirements from the beginning (volume and quality of concrete needed) and carrying out detailed characterisation before buildings are demolished. At present, Bradwell is short of recycled concrete for filling in voids. However, in future it may well produce more concrete than it can re-use.

KDC

Nigel Jenkins of KDC provided a recorded presentation on examples of projects in the nuclear sector involving re-use and recycling of crushed concrete aggregate. He said that the drivers for re-use and recycling are KDC's own corporate and social responsibility policy, the waste hierarchy and other environmental policies. Over all its nuclear and non-nuclear decommissioning and demolition projects, KDC achieves recycling of more than 97% of materials.

Challenges arise from the radioactive nature of the concrete and its other hazardous contaminants (chemicals, asbestos). The example projects included surveying, characterising and sampling in a building on a nuclear site, immobilisation of contamination, and targeted decontamination to allow subsequent demolition and recycling.

Achievements in other sectors

Waste and Resources Action Programme (WRAP)

John Barritt, the WRAP special adviser on aggregates gave a presentation on recycled concrete aggregates and WRAP tools. Uses of aggregates are in concrete, sand etc. (about 40%), as fills (34%), in asphalt (11%) and for sub-bases (15%). Markets tend to be local, that is within about 25 miles of the point of production. About 28% of the demand for aggregates is met by recycled and secondary[4] aggregates. Outside of the nuclear sector, very little crushed concrete aggregate is sent to landfill for disposal as waste; it is almost all recovered. Most of the recovered material is used in applications where unbound mixtures are required, for example in base slabs and for roads.

The WRAP Quality Protocol for aggregates was first issued in 2004. It sets out a general standard for "end of waste" quality and is widely used. In addition to the protocol, WRAP has produced guides and tools on waste avoidance, as part of its resource efficiency programme. These include guides on designing out waste in various sectors. The target is to halve the amount of waste sent to landfill by reducing the needs for raw materials in construction, maximising re-use, reducing the waste produced and recovering more of that waste. All the major construction companies have signed up to this target.

Highways Agency

Donna James of the Highways Agency was not able to be at the meeting so her presentation was given by Owen Jenkins of CIRIA. It was about use of recycled and secondary aggregates in road pavements. The Highways Agency has carried out R&D on this topic since the 1990s and remains open to the use of new materials. It uses a performance-based approach, that is one in which it is the performance of the material in its intended application that matters, not its source. There are also Environment Agency and Scottish Environment Protection Agency requirements that have to be met. The Highways Agency is involved in producing European standards for road building.

[4] Secondary aggregates are those that are by products of various processes (eg PFA).

The use of recycled and secondary aggregates is very much "business as usual" in road building. It has benefits for the client (the Highways Agency) and the supply chain. An example was given in which £15 million was saved in constructing part of the M25.

National Industrial Symbiosis Programme (NISP)

Emma James of NISP could not be present at the meeting so her presentation was given by John Barritt. NISP is a delivery body for the Department for Environment, Food and Rural Affairs (Defra) and its counterparts in the devolved administrations. It has regional delivery partners, eg SKM Enviros for the north west of England.

NISP matches organisations that have materials with organisations that need those materials in order to improve their products. It deals with a wide range of materials. The service it provides is free to users and includes putting organisations in contact with each other, facilitating the start of negotiations and following through. It has many networks of contacts in place, so that help can be provided quickly for many materials. John suggested that it might be able to help Sellafield to find customers for its concrete.

John also mentioned the ICE Demolition Protocol, which is a management system that encourages re-use and recycling. One nuclear sector example of its use was at Wylfa (see WRAP website for details). Overall, about 95% of materials produced by demolition in the UK are recovered.

Post-meeting note: Emma James has provided a recording of her slides.

A regulatory perspective

In his presentation, Paul Robinson of the Environment Agency said that, from a regulator's point of view, there are several environmental benefits in re-use and recycling of crushed concrete aggregates from nuclear sites. These include assisting in decommissioning and clean up (eg if a site is to be restored for light industrial use, recycled aggregates can be used in construction), minimising the use of new resources when building new nuclear facilities, lowering the carbon footprint of the nuclear industry and saving tax payers money.

Re-use on the nuclear site has a number of advantages. It is consistent with the proximity principle, avoids the objections of local residents to offsite disposal, and avoids transport (of wastes offsite and of new materials on to site). While the relevant regulations were not designed with re-use and recycling in mind, they can and are being applied successfully. Knowing that regulations are in place and are being complied with can also reassure the public.

The Environment Agency is about to fund a new, 18 month, project on maximising the environmental benefits from applying the waste hierarchy to low activity decommissioning wastes. The project will be carried out jointly with NDA and the nuclear industry but the output will be Environment Agency guidance and tools. The first part of the project will produce guidance and a toolbox to facilitate the application of the waste hierarchy. It will build on and update SD:SPUR work on good practice tools. The second part will consist of developing and testing lifecycle analysis tools that can be applied to waste management decisions.

Public attitudes to offsite use

Patrick Higgins of SKM Enviros gave a presentation about AWE, Cardiff, a contaminated site that was demolished by the Ministry of Defence (MOD) to slab level over the period 1998 – 2001, then handed over to Defence Estates for remediation and sale. MOD was advised that the land was valuable and could be used for housing. There was considerable stakeholder interest in the future of the land, some of it hostile. For example, partly as a result of the

activities of a pressure group, the nearest landfill refused to take wastes from work at the site.

A small area of the site was contaminated with depleted uranium and another area with beryllium. This contamination was removed and dealt with as waste. The rest of the site was mostly covered in concrete slabs. The options for it were:

1 Sell the land as it is.

2 Remove the concrete and send it to landfill.

3 Remove the concrete and re-use it.

The first option entailed reputational issues for MOD, had financial risks, did not maximise the sale value of the land and entailed residual uncertainty about land quality. The second option was not consistent with the waste hierarchy and involved the costs of landfill disposal of the concrete. So the third option was chosen. The concrete was crushed on site and sent to an intermediary, who found customers for its re-use.

Communication with stakeholders was mainly through the Local Liaison Group for the site. There were concerns about the noise and dust of crushing operations, but not about radioactive or non-radioactive contamination. Overall, the project was very successful. About 14,000 cubic metres of concrete was crushed and sent offsite, and some was used onsite for filling voids. The site was redeveloped for housing.

Discussion of barriers to re-use/recycle and overcoming them

The following is a summary of points made during the discussion.

Technical issues

- there are enough environmental standards and engineering specifications to enable crushed concrete aggregate from nuclear and defence sites to be re-used or recycled on or offsite. Mention was made during the meeting of second version of the Nuclear Industry Code of Practice on Clearance and Exemption (NICoP2, currently being prepared), as well as the WRAP Quality Protocol, the CL:AIRE Code of Practice, and various British Standards. Some sites might need assistance in identifying the most appropriate standards for their situation
- it is important to devote enough time and effort to characterisation of concrete, especially in the early stages of a decommissioning project. The best course of action is to involve people with experience in characterisation at the planning stage. It is essential to be aware that laboratory analyses can, depending on the nature of samples and contaminants, take considerable time which is often not reflected in the programme.

Regulatory issues

- the regulatory regime for nuclear sites is ill-suited to re-use and recycling of radioactive materials and wastes, either on or off a nuclear licensed site. In particular, there is as yet no mechanism for delicensing a site while radioactive materials or wastes are left in place. This will need to be resolved so as to permit *in situ* disposal (eg of radioactively contaminated basements of buildings) and to allow radioactively contaminated soils to be left where they are or to be used as infill. It is not a problem that is specific to concrete
- from a nuclear industry point of view, it is important that individual regulators adopt consistent positions on re-use and recycling. There should be no major differences from one site to another. It is also important that there is flexibility for case-by-case approaches.

Financial issues

- in the construction industry, where profit margins are low, cost is a major driver for re-use and recycling. The nuclear industry is not subject to such strong cost drivers. However, there are financial incentives for re-use and recycling in the nuclear sector, eg LLWR disposal prices have risen and will rise again, NDA incentivises its Site Licence Companies (SLCs) to reduce the costs of decommissioning.

Public confidence

- for general offsite recycling, there is a need for robust and transparent methods to demonstrate that crushed concrete is not radioactive. Independent checks can help
- there will often be objections to overcome if it is proposed to re-use or recycle concrete from one nuclear site on another nuclear site. Exceptions are when the sites are adjacent, or there are special circumstances (eg the LLWR cap).

Planning for re-use and recycling

- there is a need for forward planning for wastes that have not yet arisen, eg decommissioning wastes at Sellafield, spoil from construction of a geological disposal facility
- matching source organisations to potential customers is easy where local markets exist (eg at Harwell, concrete is sent offsite for re-use locally). Where there are difficulties, NISP could help.

Organisation and attitudes

- it is important to spread good practice for re-use and recycling of radioactive and non-radioactive materials
- there is no single organisational structure that is appropriate for waste management at all nuclear sites. However, there could be more sharing of experience to allow sites to select the one that is best for them
- there is an inherent conservatism at some nuclear and defence sites, and a tendency to be inward looking.

Conclusions

In his summing up Paul Atyeo said that there are now strong drivers for increasing re-use and recycling of crushed concrete aggregate produced at nuclear and defence sites. There appear to be solutions to most of the problems that could arise, either from inside or outside the nuclear sector. On the whole, it is up to the nuclear industry to do more. He then thanked all the speakers for their time, NISP for the venue and CIRIA for organising the event.

Marion Hill for CIRIA – SAFESPUR

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