

UTILIZING CRUSHED CONCRETE AGGREGATE IN THE CONSTRUCTION OF ROADS AND STREETS IN ACCORDANCE WITH FINNISH NEW GUIDELINES AND REGULATION

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ABSTRACT

Construction and demolition waste (C&DW) are one of the major waste types produced by modern society. To decrease the use of non-renewable natural resources as well as environmental effects of earthworks, natural aggregate materials can be replaced with recycled materials such as recycled crushed concrete aggregate. Since early 1990's crushed / recycled concrete aggregate (CCA / RCA) has been successfully used [1] in Finnish road constructions.

The aim of the article is to introduce the new guidelines [2,3,4,5,6,7] and the End-of-Waste regulation [8] for RCA published in Finland in years 2022-2023, as well as their impact on the production and utilization of concrete aggregate in the construction of roads and streets. New guidelines are including the guidance of using RCA in urban areas (street, parks, trenches, and technical networks) as well as new practices and guidelines using RCA in roads. The article also describes the new opportunities to utilize RCA introduced by End-of-Waste regulation. The new opportunities are e.g., RCA usage in substrates. New guidelines and regulations have standardized the utilization of concrete aggregate in civil engineering.

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1. INTRODUCTION

Construction and demolition waste (C&DW) constitutes a major waste category by modern society. In earthworks, reducing the reliance on non-renewable natural resources and mitigating the environmental impacts can be achieved by substituting natural aggregate materials with recycled alternatives, such as recycled crushed concrete aggregate. Since the early 1990s, crushed or recycled concrete aggregate (CCA / RCA) has been successfully utilized [1] in Finnish road construction.

2. REGULATIONS

In Finland, the most common ways to utilize RCA are Government Decree on the Recovery of Certain Wastes in Earth Construction 843/2017 [9], Environmental Permit or Government Decree on Criteria for Assessing the End of Classifying Crushed Concrete as Waste 466/2022 [8] (Table 1). Utilization of RCA is significantly impacted by the location of the site from an environmental perspective. For example, the proximity to groundwater areas or other sensitive nature sites may limit the use of RCA. In this context, it is necessary to evaluate which process is appropriate for the purpose of utilization.

Table 1. List of main regulation and decrees for utilization of RCA in Finland.

Type	Description
Government Decree on the Recovery of Certain Wastes in Earth Construction 843/2017 (in Finnish: “ <i>Valtioneuvoston asetus eräiden jätteiden hyödyntämisestä maarakentamisessa</i> ”)	The purpose of the decree is to promote utilization of wastes by defining the conditions under which the use of wastes specified in the decree for construction purposes does not require an environmental permit according to the Environmental Protection Act (527/2014).
Environmental permit under Environmental Protection Act 527/2014 (in Finnish: “ <i>Ympäristönsuojelulaki</i> ”)	An environmental permit must be applied for activities that may cause environmental pollution or the risk of pollution. The Environmental Protection Act defines professional or institutional waste treatment as an activity requiring a permit.
Government Decree on Criteria for Assessing the End of Classifying Crushed Concrete as Waste 466/2022 (in Finnish: “ <i>Valtioneuvoston asetus betonimurskeen jätteeksi luokittelun päättymisen arviointiperusteista 466/2022</i> ”)	The objective of the decree is to establish nationally applicable criteria for ending the waste classification of RCA, so that these aggregates can be introduced to the market as aggregate products and fertilizer products.

Government Decree on the Recovery of Certain Wastes in Earth Construction defines the criteria that, when met, allows the use of RCA in earth construction with notification of registration. Under the decree, the use of RCA is permitted in road and field structures, as well as in the foundation structures of industrial and storage buildings. The Centres for Economic Development,

Transport and the Environment (ELY Centre) processes the registration notification. Also, a final report describing the amount of RCA used in the site, in which structures, and coordinates of the structure is submitted to ELY Centre upon completion of the construction [9].

If the intended use, structure, or properties of the RCA do not fall within the scope of Government Decree on the Recovery of Certain Wastes in Earth Construction, utilization may be possible with an environmental permit. Regional State Administrative Agency (AVI) processes the environmental permit if the amount of RCA to be utilized exceeds 50,000 tonnes per year, or the municipal environmental protection authority if the amount is less than 50,000 tonnes. Environmentally permitted sites usually require post-monitoring and documentation. For example, monitoring of pH in groundwater and surface waters nearby the utilization site.

The national End-of-Waste (EoW) decree for RCA in Finland came into effect on September 1st, 2022. The decree defines assessment criteria for when RCA ceases to be considered as waste. The decree is applied to manufacturers who have an environmental permit for waste crushing operations under the Environmental Protection Act. Adoption of the decree is voluntary for RCA producers. In addition, the EoW decree does not override existing legislation. EoW RCA is treated as any other aggregate materials, and its use in construction does not require a permit from authorities. The user must still consider the characteristics of RCA. For example, aluminium and polyester cannot be used in RCA structures due to its high pH compared to natural aggregates.

RCA utilized in accordance with End-of-Waste decree does not require such monitoring or documentation as in Government Decree on the Recovery of Certain Wastes in Earth Construction and environmentally permitted sites. However, clients may require contractors to provide information about the structures separately (for example, city of Helsinki requires documentation provided in accordance with guidelines for documenting underground and underwater structures).

EoW decree enables new opportunities to utilize RCA, such as gabion structures, thicker structural layers such as embankments (Government Decree on the Recovery of Certain Wastes in Earth Construction has 1.5 m layer thickness limit), landscaping (no covering requirement of RCA) and substrate production (raw material source of RCA must be unused concrete products from concrete industry), and the use of RCA as aggregate in concrete production. At the beginning of 2024, there are nine EoW RCA manufacturing locations in Uusimaa region.

Besides utilizing RCA by Government Decree on the Recovery of Certain Wastes in Earth Construction, Environmental Permit or EoW decree, there are a few exception occasions for the permitting. If the use of RCA is minor, utilization may be possible with a permit granted by the municipal environmental

protection authority. Environmental regulation does not define minor waste usage, but the upper limit is often considered to be between 100 and 1000 tonnes, depending on the quality of the waste.

In addition, utilization of RCA may also be possible with an experimental operation permit, which is exempt from the need for an environmental permit. The use of an experimental procedure requires that it concerns a new activity, or, for example, waste processed in a new way, which functionality is desired to be tested.

3. QUALITY AND PRODUCTION

RCA must be CE-marked for use in earth construction when a harmonized standard exists for the specific use. The CE marking of RCA is possible for aggregate with a particle size of less than 90 mm.

The ownership of RCA and a change in ownership have implications for the CE marking obligation of the material; if the owner of the material changes before the material is utilized in a construction project, it must be CE marked. The marking is not required when the RCA is not placed on the market, but its owner operates or commissions both the production of the RCA and its installation in the structure.

Regardless of the concrete waste crushing location and the CE marking (whether present or not), the process's quality control must be conducted in accordance with the SFS 5884 standard [2] (Table 2). The final product must meet the requirements of InfraRYL (Finnish quality requirements in infrastructure construction) and the product standards relevant to its use (e.g., SFS-EN 13242 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction) as well as requirements of environmental regulations.

Previously, four quality classes were used for crushed concrete: RCA I-IV. With the introduction of the End-of-Waste regulation for RCA, the classification has been changed so that the product's waste status is directly visible from the class. Classes RCA I and RCA II have been divided into two: RCA Ia & RCA Ib and RCA IIa & RCA IIb. The “a” classes are used for RCA that ceases to be considered as waste. RCA classes Ib, IIb, III and IV will continue to be considered as waste. For RCA class I, the raw material source can only be concrete waste originating from unused concrete products from the concrete industry. For RCA classes II-IV, the raw material sources can include concrete waste from concrete industry as well as concrete waste originating from construction, renovation, or demolition sites.

Assessment and Verification of Constancy of Performance (AVCP) class differs between RCA which has waste status (RCA classes Ib, IIb, III and IV) and EoW RCA (RCA classes Ia and IIa). For waste status RCA, AVCP class

is 4 which means the quality control of the material is done by the manufacturer. Manufacturer is responsible for the performance and determination of the product. In turn, the AVCP class for End-of-Waste RCA is 2+, which requires the involvement of third parties in quality control.

Table 2. Main quality and production guideline for utilization of RCA in Finland.

Type	Description
SFS 5884:2022, Factory Production Control of crushed concrete for earth and landscape construction (in Finnish: “ <i>Betonimurskeen maa- ja viherrakennuskäytön laadunvalvontajärjestelmä</i> ”)	The standard defines how concrete waste generated in the manufacturing of building products, construction production, as well as in the repair and demolition of structures and buildings, is processed into RCA that meets the technical and environmental suitability requirements set for earth and landscaping construction.

4. UTILIZATION AND CONSTRUCTION GUIDELINES

Numerous organizations have created guidelines for utilization of RCA. For instance, Finnish Transport Infrastructure Agency has published specific guidelines for utilizing RCA within its projects. Furthermore, municipalities have developed guidelines and protocols for using RCA in urban structures and plot construction. On the other hand, material suppliers have established detailed instructions for using their materials. Main guidelines and manuals for utilizing RCA in Finland are presented in Table 3. Guidelines are binding and manuals are binding only when the client decides so.

Table 3. List of main guidelines and manuals for utilization of RCA in Finland.

Type	Description
Helsinki, Espoo, Tampere, Turku, and Vantaa cities. 2024. Crushed concrete aggregate in municipal earth construction, Guidelines for design, construction, and maintenance (in Finnish “ <i>Betonimurske kaupunkien julkisessa maarakentamisessa</i> ”). [3]	The guide addresses utilization of RCA in urban street, park, and plot construction. It considers the special features of urban construction, such as underground structures and city-specific practices.
HSY. 2024 draft will replace the existing guide from 2014. Recycled crushed concrete – A usage guide for design, construction, and maintenance (in Finnish: <i>Betonimurske – käyttöohje suunnitteluun, rakentamiseen ja ylläpitoon</i>). [10]	The guide describes the use of RCA from the perspective of the water supply network, such as filling of pipe trenches.
UUMA. 2023. Utilization of recycled materials in network projects, manual (in Finnish: “ <i>Tekniset verkostot uusi-omaarakenteissa</i> ”). [7]	The manual presents how recycled materials, substituting for natural earth materials, can be utilized in various earth structures associated with underground networks. It covers impacts of recycled materials on different network materials and the risk of permeation through water pipe walls.

Finnish Transport Infrastructure Agency. 2023. Recycled materials suitable for road construction (in Finnish “ <i>Väylärakenteisiin soveltuvia uusiomateriaaleja</i> ”). [11]	The annex compiles information on recycled materials which technical suitability has been assessed by May 30th, 2023. The criteria for assessing suitability are presented in the guide “Use of recycled materials in road construction”.
Finnish Transport Infrastructure Agency. 2022. Use of recycled materials in road construction (in Finnish: “ <i>Uusiomateriaalien käyttö väylärakentamisessa</i> ”). [12]	The guide introduces typical recycled materials for infrastructure projects, procedure for assessing the technical suitability of recycled materials, legislation, and the use of recycled materials.
Finnish Transport Infrastructure Agency. 2022. Technical suitability assessment of recycled materials (In Finnish: “ <i>Uusiomateriaalien teknisen soveltuvuuden arviointi</i> ”). [13]	This guide clarifies the procedures for assessing the general and project-specific technical suitability of recycled materials, as well as the roles and responsibilities of the assessment parties.
Finnish Transport Infrastructure Agency. 2022. Processing and utilizing of concrete waste in infrastructure projects (in Finnish “ <i>Betonijätteen käsittely ja käyttö väylähankkeissa</i> ”). [14]	The guide presents the process of processing concrete waste generated in infrastructure projects into technically and environmentally suitable RCA for infrastructure construction.
INFRA ry. 2021. Technical suitability and use of crushed concrete aggregate in road structures (in Finnish: “ <i>Betonimurskeiden tekninen soveltuvuus ja käyttö tierakenteissa</i> ”). [15]	The guide presents how the technical suitability of RCA has been assessed for use in projects under the Finnish Transport Infrastructure Agency and the ELY-Centres.
Rakennustieto Oy. 2023. InfraRYL (in Finnish: “ <i>Infrarakentamisen yleiset laatuvaatimukset, InfraRYL</i> ”). [16]	InfraRYL describes general quality requirements and accepted best practices in Finnish infrastructure construction.
City-specific guidelines [4] [5]	City-specific guidelines present general requirements for the use of RCA in urban construction projects.
Material supplier guidelines	Various material suppliers have published their own guidelines.

5. SUMMARY

In Finland, utilization of crushed / recycled concrete aggregate (CCA / RCA) is primarily influenced by its origin. It is important to know whether RCA comes from a demolition site or is a waste product of the concrete industry. In addition, it is important to know whether RCA is crushed directly on site or whether it is sent to separate production plants for processing. Regarding the production facilities, it is necessary to consider whether they have the proper environmental permits and whether they can process the concrete waste so that it can be processed into a product equivalent to natural aggregates under the End-of-Waste regulation.

In Finland, the most common ways to utilize RCA are Government Decree on the Recovery of Certain Wastes in Earth Construction, Environmental Permit or End-of-Waste decree (Table 4). Moreover, RCA can be used in accordance with municipal environmental protection authority’s minor waste utilization procedure or with an experimental operation permit.

Table 4. Processing and utilization of RCA (simplified).

	RCA with waste status	End-of-Waste RCA
Processing ¹⁾	Internal quality control	Third-party quality control
Regulation	Government Decree on the Recovery of Certain Wastes in Earth Construction, Environmental Permit	RCA End-of-Waste Decree
Construction	InfraRYL, Client specific guidelines and manuals, Material supplier guidelines	
Post-construction supervision	ELY Centres, Municipal environmental protection authority, Regional State Administrative Agency (AVI)	No supervision regarding construction of RCA structures which means the responsibility of client, constructor, and designer is emphasized.

¹⁾ *Assessment and verification of constancy of performance (AVCP) class 4 is sufficient for RCA with waste status which means internal quality control by the manufacturer is adequate. The AVCP class for End-of-Waste RCA is 2+, which requires the involvement of third parties in quality control.*

Technical requirements of the site impact on use of RCA. For instance, the load and environmental conditions must be suitable for the use of RCA, and the chemical properties of RCA must be compatible with the equipment and devices presents in the structures. When RCA is used in construction, quality assurance often occurs through InfraRYL (Finnish quality requirements in infrastructure construction). InfraRYL outlines the general quality requirements for RCA and provides guidance on conducting quality control measurements of built structure.

Various organizations have developed guidelines and manuals for the utilization of RCA. For example, Finnish Transport Infrastructure Agency has published its own guidelines for using RCA in its operations. Additionally, cities have released guidelines for utilizing RCA in urban structures and plots. Material suppliers, in turn, create detailed instructions for using their own materials.

REFERENCES

- [1] Dettenborn, T., Forsman, J. and Korkiala-Tanttu, L. 2015. Crushed concrete in road structures - two decades of experience. Proceedings of the Institution of Civil Engineers - Construction Materials ISSN 1747-650X. DOI: 10.1680/jcoma.15.00005.
- [2] SFS 5884. 2022. Factory Production Control of crushed concrete for earth and landscape construction (in Finnish “*Betonimurskeen maa- ja viherrakennuskäytön laadunvalvontajärjestelmä*”).

- [3] Helsinki, Espoo, Tampere, Turku, and Vantaa cities. 2024. Crushed concrete aggregate in municipal earth construction, Guidelines for design, construction, and maintenance (in Finnish “*Betonimurske kaupunkien julkisessa maarakentamisessa*”).
- [4] The City of Helsinki. 2023. Quality requirements for crushed concrete aggregate to be used in Helsinki city projects (in Finnish “*Laatuvaatimukset Helsingin kaupungin kohteissa hyödynnettävälle betonimurskeelle*”).
- [5] The City of Espoo. 2023. Quality requirements for crushed concrete aggregate to be used in Espoo city projects (in Finnish “*Laatuvaatimukset Espoon kaupungin kohteissa hyödynnettävälle betonimurskeelle*”).
- [6] Finnish transport infrastructure agency. 2022 The use of recycled materials in road construction (in Finnish: “*Uusiomateriaalien käyttö väylärakentamisessa*”).
- [7] UUMA4. 2023. Utilization of recycled materials in network projects, guideline (in Finnish: “*Tekniset verkostot uusiomaarakenteissa*”).
- [8] Government Decree on Criteria for Assessing the End of Classifying Crushed Concrete as Waste 466/2022 (in Finnish: “*Valtioneuvoston asetus betonimurskeen jätteen luokittelun päättymisen arviointiperusteista 466/2022*”).
- [9] Government Decree on the Recovery of Certain Wastes in Earth Construction 843/2017 (in Finnish: “*Valtioneuvoston asetus eräiden jätteiden hyödyntämisestä maarakentamisessa*”).
- [10] HSY. 2024 draft. Recycled crushed concrete – A usage guide for design, construction, and maintenance (in Finnish: *Betonimurske – käyttöohje suunnitteluun, rakentamiseen ja ylläpitoon*)
- [11] Finnish Transport Infrastructure Agency. 2023. Recycled materials suitable for road construction (in Finnish “*Väylärakenteisiin soveltuvia uusiomateriaaleja*”)
- [12] Finnish Transport Infrastructure Agency. 2022. Use of recycled materials in road construction (in Finnish: “*Uusiomateriaalien käyttö väylärakentamisessa*”)
- [13] Finnish Transport Infrastructure Agency. 2022. Technical suitability assessment of recycled materials (In Finnish: “*Uusiomateriaalien teknisen soveltuvuuden arviointi*”)
- [14] Finnish Transport Infrastructure Agency. 2022. Processing and utilizing of concrete waste in infrastructure projects (in Finnish “*Betonijätteen käsittely ja käyttö väylähankkeissa*”)
- [15] INFRA ry. 2021. Technical suitability and use of crushed concrete aggregate in road structures (in Finnish: “*Betonimurskeiden tekninen soveltuvuus ja käyttö tierakenteissa*”)
- [16] Rakennustieto Oy. 2023. InfraRYL (in Finnish: “*Infrarakentamisen yleiset laatuvaatimukset, InfraRYL*”).