

# **A Norwegian Certification Scheme for Recycled Aggregate (RCA)**

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## **1. INTRODUCTION**

As a part of the Norwegian research project RESIBA, a certification scheme for recycled aggregate has been established. RESIBA was a 3-yearly project supported by the Norwegian EcoBuild and was finalized spring 2002. The aim of the project as a whole was to formulate recommendations for areas of use of RCA, requirements for properties depending of the area of use and finally means of assuring the quality of RCA. Quality assurance of RCA was the main motivation for drawing up a certification scheme for RCA.

Besides being based on experience from practical applications of RCA in different areas of use, the work of RESIBA was based on ongoing work within the European Community. This especially applied to the development of European standards for aggregate. A similar Dutch certification scheme was also of importance in the work. Formal legislation concerning environmental issues was also considered working with the document.

The main aim and motivation for developing the certification scheme was to give users of RCA confidence to the material itself, especially concerning environmental aspects, but also concerning the importance of having properties with defined tolerances on variation throughout a delivery.

As part of the work of the project it was also seen as important to classify RCA. This classification of recycled aggregate is stated in an Appendix to this document.

## **2. PRODUCTION CONTROL SYSTEM**

As in the forthcoming harmonized European Standards for aggregate this scheme for recycled aggregate is based on a requirement to the production control system of the producer. All basic elements of this system should be described by means of a Quality Manual. The manual should describe or comprise all established and implemented procedures and instructions concerning the production of recycled aggregate.

Furthermore it must be described how maintenance of the manual are taken care of, the handling of non-conforming products and corrective actions taken, the authority and

responsability for leading personell, the training and education of personell, the established control plans and final documentation and filing of documents.

### **3. INSPECTION OF BUILDING MATERIALS UPON RECEIPT**

To have confidence in the final RCA products with respect to dangerous substances and thus to avoid extensive testing of the final product, it has been seen as vital to have necessary knowledge of the construction and demolition material to be recycled. Ideally the best way to ensure this would have been to require pre-evaluation of the construction and demolition materials with respect to both dangerous substances and contaminations before transport to the producer of RCA.

In some Norwegian communities local legislation require both pre-evaluation of the construction and a demolition plan based on this pre-evalutaion. These documents are publicly available and thus they will be of importance to the producer of RCA. For use in concrete the Publication no. 26 from the Norwegian Concrete Association also require a special pre-evalutaion of the conctruction with respect to possible contamination of special importance for re-use in concrete. As the Norwegian legislation in general so far do not require this, it has however been necessary to find alternative ways to ensure knowledge on the building materials reveiced at the production site.

Because of the situation in Norway both regarding the legislation but so far also with respect to how demolition material are delivered to the producer of RCA, with normally no documentation accompanying the delivery, the suggested certification scheme requires the producer to have established procedures cocncerning the receipt of demolition material. The documentation established through these procedures should indicate the type of material, the origin of the material, the transporting agent, possible contaminants and if relevant corresponding results from pre-analyses of the construction and/or demolition material. It is also required that personell responsible for reception inspection are specially trained for this job and that this training are documented. Finally it is also required a certain testing of the RCA products to ensure the quality, see table 1 of this document.

### **4. PRODUCTION AND TESTING OF RCA PRODUCTS**

The production itself should be managed by means of the established and implemented procedures, routines and instructions. In addition the results from the testing of the final products are considered to be an important input as to the management of the production. It is considered as vital that the producer has a certain minimum of laboratory equipment either on site or nearby. This to be able to make use of the results to manage the production. It is also required that laboratory personell have undergone training and that all equipment are maintained, checked and calibrated according to established procedures and standards in forth.

Testing of final products shall be carried out at the minimum frequency required in table 1. The given minimum frequencies presumes a relatively continous production with even materials, otherwise the frequencies have to be increased. On the other hand the frequencies might be decreased if the producer document very stable product properties. This is to be done in agreement with the customer or the certification body.

Table 1 Test frequency for bound and unbound use

Property to be tested	Test method	To be tested by (type of lab.)	Test frequency at continuous production	
			Products for bound use (for concrete)	Products for unbound use
Grading	EN 933-1	L <sup>1)</sup>	One per week or min. per 2000 tons	
Fines content ( materials < 0,063 mm calculated on materials < 19 mm)	EN 933-1	L <sup>1)</sup>	One per week or min. per 2000 tons	
Content of materials < 0,020 mm calculated on materials < 19 mm		L <sup>1)</sup>	-	If required
Material composition	prEN 933-11	L <sup>1)</sup>	One per week or min. per 2000 tons	
Organic materials <sup>5)</sup>	EN 1744-1	L <sup>1)</sup>	One per week or min. per 3000 tons	-
Shape - Flakiness index (of materials > 8 mm)	EN 933-3	L/C/E <sup>2)</sup>	One per month	
Mechanical properties (Los Angles)	EN 1097-2	L/C/E <sup>2)</sup>	-	One per two weeks or min. per 10 000 tons
Density	EN 1097-6	L/C/E <sup>2)</sup>	One per two weeks or min. per 10 000 tons	
Water absorption	EN 1097-6	L/C/E <sup>2)</sup>	One per two weeks or min. per 10 000 tons	
Chloride content <sup>5)</sup>	EN 1744-1	L/C/E <sup>2)</sup>	One per two weeks or min. per 10 000 tons	If required
Sulfur-containing compounds	EN 1744-1	L/C/E <sup>2)</sup>	If required	If required
Chemical analyses <sup>4)</sup> (Leaching test)	EN 1744-3	A <sup>3)</sup>	-	One per two weeks or min. per 10 000 tons

- 1) Should be tested at the production site to be able to manage the production on basis of the test results  
2) Might be tested either locally, at a central laboratory or external  
3) To be tested either at a third party approved or accredited laboratory  
4) Alternative methods might be accepted  
5) The test frequency might be reduced by 50 % if it is carried out pre-evaluation of the building according to Publication no. 26 from the Norwegian Concrete Association

## 5. DOCUMENTATION OF THE RCA PROPERTIES

Based on experience from his production and the test results the producer shall work out a document of declared values for the requested properties dependent on the end use. This document shall also state within which tolerances or maximum/minimum levels the user can expect his material to be delivered. At the start of the project RESIBA it was aimed to fix these tolerances and limits as it had been done for natural aggregate. At the end of the project it was however considered that the number of results from the different practical projects were to low to fix these limits.

In the certification scheme it is stated the number of test results to be basis for the declared values. In cases where it is a need for revising one or more of the declared values the scheme also states the number of results to be basis for such a revision. Basically all a user of recycled aggregate should need is the data sheet with declared values and tolerances/limits from the producer.

During production and testing the producer is required to compare his test results with his declared values and limits given on the data sheet and act according to the outcome of such an evaluation. If he obtains results outside of what he has declared he is obliged to inform his customer.

## **6. CONCLUSIONS**

The described certification scheme has been established as a voluntary certification scheme. It has been established with the aim to help increase the use of RCA and to give the user confidence in the product. It is recommended that the user require of his supplier of RCA that he is certified according to the requirements of the scheme. If not possible the user should at least use the scheme as an aid when drawing up specifications and requiring documentation for his delivery of RCA. It is also considered that the certification scheme will need to be amended and/or revised based both on experience with the scheme and the development on legislation nationally and standardization within the European Community. This work will be undertaken by Kontrollrådet for betongprodukter both as one of the participants in the project and as a certification body.

## **7. REFERENCES**

The Norwegian Concrete Association: Publication no. 26. Recycling of concrete and masonry for re-use in concrete

Kontrollrådet for betongprodukter: Certification scheme for natural aggregates for concrete

Public Roads Administration: Manual – 014 : Laboratory tests

The Norwegian Building Regulations 97

The Community of Oslo: Regulation concerning the management of production waste

BRL 2506: Dutsch guideline for certification of RCA

RESIBA: Use of recycled aggregates – Status 2000

## APPENDIX

### Classification of recycled aggregate

The classification of recycled aggregate for bound (cement) use is based on Publication no. 26 from the Norwegian Concrete Association and the experiences from the RESIBA-project.

The given minimum frequencies for material composition for the following four types are general requirements. Depending on the end use of the recycled aggregate it will normally be necessary to add requirements concerning the properties of the recycled aggregate.

If nothing else is stated the percentages given in the table is to be calculated on mass.

	Type 1 "Crushed concrete"		Type 2 "Mixed materials"	
	A - Bound use	B - Unbound use	A - Bound use	B - Unbound use
<b>Main materials :</b>				
Crushed concrete and/or natural aggregate	> 94 %		-	
Crushed concrete, crushed masonry and natural aggregate			> 90 % <sup>1)</sup>	
<b>Other granular materials :</b>				
Crushed masonry	< 5 %	< 5 %	-	-
Crushed asphalt	< 1 %	< 5 %	< 1 %	< 5 %
<b>Non-mineral contents :</b>				
Wood, paper, metals, soft material <sup>*)</sup> , organic materials <sup>**)</sup> , plastics, glass, rubber, others	< 1 %		< 2,5 %	
<sup>*)</sup> Soft materials	< 0,1 v. % <sup>2)</sup>		< 0,5 v. % <sup>2)</sup>	
<sup>**)</sup> Organic materials	< 0,1 v. % <sup>2)</sup>		< 0,5 v. % <sup>2)</sup>	
Density – oven dry <sup>3)</sup>	> 2000 kg/m <sup>3</sup>		> 1500 kg/m <sup>3</sup>	
- water dense, surface dry <sup>3)</sup>	> 2100 kg/m <sup>3</sup>		> 1800 kg/m <sup>3</sup>	
Water absorption	< 10 %		< 20 %	

<sup>1)</sup> for end uses where it is laid down requirements to properties other than material composition it is recommended to keep the percentage of concrete and/or natural aggregate at minimum 80

<sup>2)</sup> the percentage organic materials and isolation materials are to be calculated on volum

<sup>3)</sup> to be tested according to EN 1097-6. The requirement to be fulfilled by at least one of the methods.