ANNEX 15

Recommendations for using recycled concrete

1 Scope

For the purposes of this Annex, recycled concrete (RC) is defined as concrete manufactured using coarse recycled aggregate from processed concrete waste.

For its application in structural concrete, this Annex recommends limiting the content of coarse recycled aggregate up to 20% by weight out of the total weight of coarse aggregate. With this limitation, the final properties of recycled concrete are hardly affected compared to results obtained for conventional concrete. For higher percentages, special studies and complementary experiments are required for each application. The Annex gives information on some of the concrete properties that may be affected with substitutions greater than the indicated limit.

This document only considers the points that complement the requirements set out in the various articles of this Code or that replace them in certain cases. Other specifications that do not contradict those laid down in the Annex remain in force.

Recycled aggregate may be used for mass concrete and reinforced concrete with characteristic strength no greater than 40 N/mm^2 while its use in prestressed concrete is excluded.

The following types of concrete are outside the scope of this annex:

- Concrete manufactured using fine recycled aggregate.
- Concretes manufactured using recycled aggregates of a nature other than concrete (mainly ceramic, asphalt aggregates, etc.).
- Concretes manufactured using recycled aggregates from concrete structures with conditions that affect the quality of the concrete such as alkali-aggregate, sulphate attack, fire, etc.
- Concretes manufactured using recycled aggregates from special concretes such as aluminium concretes, fibre-reinforced, polymer-reinforced, etc.

2 Complements to the text of this Code

Recommendations for use of recycled concrete are indicated below with reference to the Titles, Chapters, Articles and Sections of this Code

TITLE 1. BASIS OF DESIGN

CHAPTER III Actions

Article 10 Characteristic values of actions

10.2 Characteristic values of permanent actions

In the case of recycled concretes with a recycled aggregate percentage less or equal than 20%, the characteristic values of the deadweight are obtained from the same density value laid down in this Guidelines.

- Mass concrete 2,300 kg/m^3
- Reinforced concrete 2,500 kg/m^3

For recycled coarse aggregate percentages greater than 20%, the resulting density of the recycled concrete is less than that of conventional concrete of the same density as a recycled aggregate due to the mortar that remains attached to the natural aggregate. The higher the percentage o recycled aggregate used, the lower the density of concrete. For total replacement of coarse aggregate, the reductions are therefore between 5-15% of the density of a conventional concrete.

TITLE 3. TECHNICAL PROPERTIES OF MATERIALS

CHAPTER IV Materials

Article 26 Cement

The type of cement used in the manufacture of concretes with recycled aggregate shall be the same as used in a conventional concrete for the same application.

Article 28. Aggregates

28.1 General

The combination of natural and recycled coarse aggregate shall satisfy the specifications laid down in Article 28 of this Code. This Annex sets out the requirements to be met by recycled coarse aggregates and also those specifications laid down for natural aggregates to ensure the mixture of both complies with the requirements laid down in Article 28.

In general, test methods laid down in this Code shall be used for recycled aggregates although in some cases change may be necessary as indicated in the corresponding sections.

Natural aggregates or obtained from ground rocks may be used to manufacture recycled concrete.

It is considered that recycled aggregates obtained from normal structural concretes or from high strength concretes are sufficient for the manufacture of structural recycled concrete although a check shall be carried out to ensure they meet the specifications laid down in the following sections.

Recycled aggregate batches shall provide a document identifying the waste source that includes the following aspects:

-nature of material (mass concrete, reinforced concrete, concrete mixture, etc.),

-aggregate production plant and waste carrier company,

-presence of impurities (ceramics, wood, asphalt),

-details on source (origin or type of structure obtained from),

-any other information of interest (cause of demolition, chloride contamination, concrete affected by alkali-aggregate reactions, etc.).

Separate and identified stockpiles shall be established for recycled aggregates and natural aggregates.

It is advisable for recycled aggregates from concretes of very different qualities to be stored separately due to the fact that the quality of the original concrete affects the quality of the recycled aggregate, obtaining aggregates with improved properties from high quality concretes. One possible distinction may be to store waste from structural concrete or high strength concrete separately from that obtained from non-structural concrete to permit greater uniformity in the properties of the produced recycled aggregates.

28.2 Designation of aggregates

Recycled aggregates shall be designated with the format laid down in Article 28 of this Code, and shall be designated "R" in the "Nature" section.

28.3 Maximum and minimum aggregate sizes

The minimum permitted size for recycled aggregate is 4 mm.

28.4 Aggregate particle size grading

Plants producing recycled aggregates generally obtain a coarse fraction with an appropriate shape coefficient, flakiness index and grading within the limits recommended for its use in structural concrete.

Recycled aggregates shall display an undersize particle content less than or equal to 10% and a content of particles passing through a 4 mm screen no greater than 5%.

The undersize particle content of recycled aggregate is usually greater than that of natural aggregates due to the fact that these may be generated after sieving during storage and transport due to their greater friability. The fine recycled fraction is also characterised by its higher content of mortar, that negatively affect the quality of the concrete. This is the main reason why their use is restricted in the application of structural concrete.

28.6 Physical-mechanical requirements

In recycled concrete with a content of recycled aggregate no greater than 20%, the content of clay lumps shall be no greater than 0.6% and that of natural coarse aggregate no greater than 0.15%.

If recycled concrete includes recycled aggregate quantities greater than 20%, precautions shall be taken during its production to eliminate as far as possible soil impurities within the raw material and ensures that the combined aggregate complies with the specifications in this Code. In the extreme case of using 100% recycled coarse aggregate, this shall meet the maximum specification of 0.25% of clay lumps.

28.6.1 Physical-mechanical requirements

In recycled concrete with a recycled aggregate content no greater than 20%, the absorption of recycled aggregate shall be no greater than 7%. The absorption of natural coarse aggregate shall also be no greater than 4.5%.

The requirement for the recycled aggregate abrasion resistance is the same as for natural aggregates (Los Angeles coefficient no greater than 40%).

In recycled concretes with more than 20% of recycled aggregate, the combination of natural aggregate and recycled coarse aggregate shall comply with the specifications laid down in this Code with an absorption of water no greater than 5%.

As a first check in a production plant, to estimate the water absorption of recycled aggregates, an absorption test may be carried out after 10 minutes that should be less than 5.5% for recycled aggregate applications no greater than 20%.

In the case of concrete exposed to freezing environments, to determine the maximum weight loss experienced by recycled aggregates when they are subject to treatment cycles with magnesium sulphate solutions, the sample shall be prepared beforehand by washing and sieving vigorously through a 10 mm sieve to eliminate all friable particles prior the test procedure described in UNE-EN 1367 Part 2. The limit to the test result laid down in this Code for natural aggregates shall also be applied to recycled coarse aggregates.

28.7 Chemical requirements

The specifications in the Article relating to the chloride content and sulphate content shall be maintained.

Recycled aggregates may include impurities and contaminants that negatively affect concrete properties. These contaminants may be very varied, e.g. plastic, wood, plaster, brick, glass, organic material, aluminium, asphalt, etc. These impurities cause in all cases a decrease of compressive strength in concrete. Also, depending on the type of impurity, other problems may arise such as alkali-aggregate reactions (glass), sulphate attack (plaster), “pop-out” (wood or paper), high shrinkage (clay soils) or a low resistance to thaw-freeze (some ceramic materials).

The impurity contents shall be checked in the recycled aggregate, establishing the maximum values given in Table A15.1:

TABLE A.15.* Maximum impurities content in recycled aggregates

Elements	Max. Impurity content % of total sample weight
Ceramics	5
Lightweight particles	1
Asphalt	1
Other materials (glass, plastics, metals, etc.)	1,0

28.7.1 Chlorides

Recycled aggregates may have an appreciable content of chloride depending on the source of the concrete used as a raw material, particularly in concretes from maritime works, bridges or pavements exposed to de-icing salts. Concretes that have been manufactured using accelerant additives may also contain a high level of chlorides.

It is advisable to determine the total chloride content instead of the water-soluble chloride content, applying the same limit laid down in this Code for the latter. This is due to the possibility

of certain combined chlorides that in certain circumstances may be reactive and attack the reinforcement. UNE-EN196-2 may be used to determine total chloride in recycled aggregate.

28.7.4 Organic material compounds that alter the setting and hardening rates of concrete

The test method included in UNE-EN 1744-1 for determining the content of lightweight particles present several problems when used in recycled aggregates because the solution becomes clouded with soil particles and its density changes. This means that the samples must be washed beforehand and then dried before the test is carried out.

28.7.6 Alkali-aggregate reactivity

The recycled aggregates will not present potential reactivity with the alkalis in concrete. In the case of recycled aggregates obtained from a single concrete of controlled source, i.e. concretes of known composition and characteristics, the same verifications established in this Code articles shall be carried out. In the case of recycled aggregates from different source concretes, these shall be considered potentially reactive.

Article 29 Admixtures

In recycled concretes with substitutions greater than 20%, the use of admixtures that modify rheology is recommendable to improve workability since it makes up for the higher water absorption by recycled aggregate when this is used in a dry state.

Article 30 Additions

Additions may be used under the same terms indicated in the article.

TITLE 4. DURABILITY

CHAPTER VII Durability

Article 37 Durability of concrete and reinforcements

37.2.4 Reinforcement covers

This Code set out minimum concrete cover depending on its strength and the exposure class, which are applied for concretes with a recycled aggregate content no greater than 20%.

For concretes with a higher recycled aggregate content, the cover in this Code may be maintained if the concrete mix design adopted guarantee a similar durability to that required in this Code for conventional concrete in each exposure class, as indicated in article 37.3 for corrosive environments by means of the relevant studies.

Only in the case of maintaining the same concrete mix as for conventional concrete may it be necessary to provide thicker cover to compensate the increased porosity of the recycled concrete, according to the specific studies carried out in each case.

37.3. Durability of the concrete

The durability of recycled concrete with a recycled aggregate content no greater than 20% is similar to that of a conventional concrete as far as the specifications in the article are applicable.

The higher porosity of recycled aggregate makes the recycled concrete incorporating such aggregate more susceptible to environmental effects, however, which means special measures shall be adopted when used in corrosive environments with percentage of recycled aggregate greater than 20%. This behaviour shall be taken into account in the concrete mix by increasing

the cement concrete or reducing the water/cement ratio. Another possibility is to increase the reinforcement cover required in certain corrosive environments.

37.3.2. Limitation on water and cement content

In recycled concrete containing more than 20% of recycled aggregate, the values laid down in Table 37.3.2.a may be insufficient and it may be advisable to adjust the concrete mix proportion to ensure the requirements referring to the water penetration test results as laid down in this article are complied with for all exposure classes except I and IIb.

For substitutions of recycled aggregate greater than 20%, the minimum strength compatible with the durability requirements may be greater than those set out in table 37.3.2.b.

37.3.4. Frost resistance of concrete

When the recycled concrete is subject to exposure class H or F, the recycled aggregates shall comply with the specification relating to stability of aggregates to sodium sulphate or magnesium sulphate solutions.

When the recycled concrete is subject to exposure class H or F, a minimum air entrained content of 4.5% shall be introduced.

In the case of concrete containing more than 20% of recycled aggregates, special tests shall be carried out with the recycled concrete mix design adopted.

37.3.5. Sulphate-resistance of concrete

In this type of exposure class, the use of recycled aggregate is dependent on knowledge of the source of the original concrete, which must have been manufactured with sulphate-resistant cement.

37.3.6. Seawater resistance of concrete

In this type of exposure class, the use of recycled aggregate is dependent on knowledge of the source of the original concrete, which must have been manufactured with sea water-resistant cement.

37.3.7. Erosion resistance of concrete

The recycled aggregate shall comply with the specifications set out in the article in the Los Angeles coefficient, which shall be less than 30%.

The limitation established for the Los Angeles coefficient is difficult to comply with in recycled aggregates because they usually display higher abrasion due to the adherent mortar.

37.3.8. Alkali-aggregate reactivity resistance

In environments exposed to humidity, other than I and IIb, it is advisable to use recycled aggregates from a single concrete of controlled origin as set out in article 28.7.6 of this Annex. In this case, reactivity tests shall be carried out on the recycled and natural aggregate mixture to be used in the work.

In these environments and in the case of using recycled aggregates of different sources, the measures laid down in this Code for use of potentially reactive aggregates shall be applied as a precaution.

37.4. Corrosion of reinforcements

As with the other properties, concretes with a recycled aggregate content no greater than 20% display a satisfactory performance with regard to corrosion.

For concretes with recycled aggregate percentages greater than 20%, the corrosion protection is lower than that offered by conventional concrete with the same mix design and for this reason it is advisable to carry out specific tests in each case.

TITLE 5 DESIGN

CHAPTER VIII Information concerning materials to be used in structures

Article 39 Characteristics of concrete

39.1. Definitions

For recycled concrete with a recycled coarse aggregate no greater than 20%, the equations in the article for calculating tensile strength may be used. For substitution percentages higher than 20%, this property is hardly affected although the carrying out of tests is advisable in each case.

39.2. Identification of concretes

The code T indicates whether the concrete type will be HRM or HRA according to whether the concretes are mass or reinforced respectively, manufactured using recycled aggregates. As far as characteristic strength is concerned, it is advisable to use the series laid down in the article with the upper limit of 40 N/mm^2.

39.5. Design stress-strain diagram of concrete

The diagram in the article applies to recycled concretes with a coarse aggregate substitution percentage no greater than 20%.

For recycled aggregate percentages greater than 20%, two aspects of the stress-strain diagram may be affected:

On the one hand, there is an increase in peak strain sc1 as the recycled aggregate percentage increases due to the higher susceptibility of such aggregates to strain.

On the other hand, greater strength loss may occur, compared with conventional concrete, in tests under sustained loads.

In such cases it is therefore advisable to carry out specific studies to establish the design diagram to be used.

39.6. Modulus of elasticity of concrete

The equation and notes tables used in the article to calculate the modulus of elasticity of the concrete applies to concretes with a recycled coarse aggregate percentage no greater than 20%.

For recycled aggregate substitutions greater than 20%, the modulus of elasticity decreases progressively as the recycled aggregate percentage increases.

As a guideline and for 100% recycled coarse aggregate, the concrete modulus of elasticity shall be 0.8 times that of conventional concrete. Due to the change in quality of recycled aggregates, a high dispersion may nevertheless arise in the value of the modulus (since values even lower than that given may arise), which makes it advisable to carry out tests in each case.

39.7. Shrinkage of concrete

The article equation and tables and also the notes for estimating concrete shrinkage apply to concretes with a recycled coarse aggregate substitution no greater than 20%.

For recycled aggregate substitutions above than 20%, the shrinkage increases gradually as the recycled aggregate percentage increases. As a guideline and for 100% recycled coarse aggregate, shrinkage shall be 1.5 times that of a conventional concrete. Due to the change in quality of recycled aggregates, a high dispersion may arise in the shrinkage value (some values may be higher than indicated), which makes it advisable to carry out tests in each case.

39.8. Creep of concrete

The article equation and tables and also the notes, for estimating concrete creep rate apply to concretes with a recycled coarse aggregate substitution no greater than 20%.

For recycled aggregate substitutions above than 20%, the creep rate increases gradually as the recycled aggregate percentage increases. When calculating creep rate, this effect is shown through the decrease in the longitudinal modulus of elasticity as indicate in article 39.6 of this Annex. In this case, as a guide value for 100% recycled coarse aggregate, the creep coefficient shall be 1.25 times that of a conventional concrete. Due to the change in quality of recycled aggregates, a high dispersion may arise in the creep rate value (some values may be higher than indicated), which makes it advisable to carry out tests in each case.

CHAPTER IX Carrying capacity of struts, ties and nodes

Article 40. Carrying capacity of struts, ties and nodes

The resistant capacity of rods and nodes in recycle concretes with a recycled aggregate content no greater than 20% is the same as for conventional concretes.

For substitution percentages greater than 20%, the reduction in strength under sustained load may be significant: Specific tests are advisable in such cases as discussed in article 39.5.

CHAPTER X Design for ultimate limit states

Articles in this chapter apply to concretes with recycled aggregate substitutions no greater than 20%. In other cases, it is advisable to carry out specific studies in accordance with the remarks set out in articles 39 and 40.

CHAPTER XI Design for serviceability limit states

Article 49. Cracking Limit State

The contents of this article of this Code are maintained except with regard to maximum separation between stirrups that shall adopt a maximum value of 200 mm for recycled concrete with the aim of improving the response to cracking under a shear stress.

For coarse aggregate percentages higher than 20%, specific studies should be carried out or an experimental campaign should be developed.

Article 50. Deformation Limit State

In the case of recycled concrete with substitution no greater than 20% that is not particular susceptible to strain, the specifications laid down in the article apply.

In components highly susceptible to strain and particularly for recycled aggregate percentages higher than 20%, specific studies shall be carried out or an experimental campaign shall be applied in previous tests.

Article 51. Vibration limit state

In concrete elements with a substitution percentage no greater than 20% of recycled aggregate, the specifications in the article apply.

TITLE 6 STRUCTURAL ELEMENTS

CHAPTER XII Structural Elements

All the articles in this chapter take into account the considerations set out in this Annex.

TITLE 7. EXECUTION

CHAPTER XIII Execution

Article 69 Construction, reinforcing and assembly processes for reinforcements

69.5 Specific criteria for anchorage and splicing of reinforcements

For concretes with substitution percentage no greater than 20% of recycled aggregate, the specifications laid down in this article in this Code apply.

For substitutions higher than 20%, a slight reduction has been noted in the adherence capacity between the corrugated bars and recycled concrete. In the absence of specific experimental results, the following equation may be adopted for the basic anchorage length:

For bars in position I:

$$l_b i=1,1nH^2>(f_{yk}/20)\ \phi$$

For bars in position II:

$$l_{bII} = 1,55\ m\phi^2 \geq (f_{yk}/14)\ \phi.$$

Article 71 Elaboration and placing of concrete

71.2.3. Mix design installations

The water absorption of recycled coarse aggregate is high and it is therefore advisable to use aggregates in saturated conditions for concreting using more than 20% of recycled aggregates. To maintain the moisture content, systems that humidify the aggregate in conveyor belts may be installed in the mixing plants or water sprinklers in the aggregate hoppers.

71.3 Concrete elaboration

It is advisable for concrete containing recycled aggregate to be prepared in a mixing plant.

71.3.1. Supply and storage of component materials

Separate stockpiles shall be established and identified for recycled aggregates and natural aggregates.

71.3.2 Mix proportions of component materials

Normal mix design methods for conventional concretes apply to recycled concretes with a recycled aggregate percentage no greater than 20%. In any case, it is advisable to carry out previous tests to adjust the mix design.

In recycled concretes with substitution greater than 20% and due to the lower quality of recycled aggregates, concrete manufactured using recycled aggregates requires a higher content of cement or a lower water/cement ratio in the dosage to maintain the same strength and durability as for a conventional concrete.

Equally, to achieve the required consistency, it is usually necessary to add more water to the dose to compensate for the higher absorption of recycled aggregate. Other possibilities may be to use plasticizing or superplasticizing admixtures in the dosage or to presoak the recycled aggregate.

71.3.3. Mixing

Mixing concrete with recycled aggregates in a dry state may take longer than for conventional concrete. This allows the moistening of aggregates with the aim of preventing water absorption by the recycled aggregate affecting the concrete consistency.

The mixing time must nevertheless not be excessively extended to prevent the generation of fines due to the friability of the attached mortar of the recycled aggregate. It is advisable to adjust the mixing time by carrying out characteristic tests.

71.3.4 Designation and characteristics

When designating the recycled concrete, the designation shall show that the product is concrete manufactured using recycled aggregates as specified in section 39.2 of the present Annex.

71.4 Transport of concrete

The transported recycle concrete volume shall not exceed two thirds of the total volume of the transporter drum in any case.

In concretes with substitutions greater than 20% of recycled aggregate, it may be advisable to carry out characteristic tests to evaluate the change in consistency during transport and make up for this change by adding plasticizing or superplasticizing admixture on site following the concrete manufacturer's guidelines.

71.5. Placing of concrete

In the case of pumped concrete, the pumping pressure may alter the homogeneity of recycled concrete characteristics due to its effect on water absorption of recycled aggregate. The concrete mix design shall, therefore, be adjusted by carrying out characteristic tests and taking samples at the pipe output.

TITLE 8 CONTROL

CHAPTER XV Control of materials

Article 79. Conditions for the conformity of the structure

79.3.1 Documentary control of supplies

When the recycled aggregate comes from a single origin concrete, the control required shall be the same as laid down in the article for conventional aggregates.

The greater heterogeneity usually presented by recycled aggregates when are obtained from various types of original concretes make it necessary to carry out greater control of their properties, especially those that are most unfavourable in this type of aggregate such as absorption, fine content, undersize fraction and impurity content.

In this case, the frequency of production control tests determined on the basis of time or recycled aggregate quantity shall be defined by the most conservative criteria of those set out in the following table:

TABLE A 15.2 Production inspection test frequency

PROPERTY	STANDARD	FREQUENCY	
Grading. Undersize fraction components	UNE-EN 933-1	1/week	Every 2000 t.
Shape index	UNE-EN 933 -4	1/month	Every 10000 t.
Fine content	UNE-EN 933-2	1/week	Every 2000 t.
Los Angeles coefficient	UNE-EN 1097-2	1/month	Every 2000 t.
Absorption	UNE-EN 1097-6	1/week	Every 2000 t.
Stability to $MgSO_4$ solution (*)	UNE-EN 1367-2	1/ 6 months	Every 10000 t.
Clay lumps	UNE 7133	1/week	Every 2000 t.
Lightweight particles	UNE 7244	1/ month	Every 10000 t.
Determination of sulphur compound (SO_3)	UNE-EN 1744-1	1/ 3 month	Every 10000 t.
Determination of acid-soluble sulfates (SO_3)	UNE-EN 1744-1	1/ 3 month	Every 10000 t.
Determination of total chloride	UNE-EN 1744-1	1/ 3 month	Every 10000 t.
Impurity content	EN 933-11	1/week	Every 2000 t.

(*) Only applicable in frost or de-icing salt environment

CHAPTER XVI

Article 86. Concrete control

86.4. Control prior to construction

Experience with conventional concrete mixing is not directly applicable to recycled concrete and previous tests are therefore very advisable. These tests shall also be used to analyze the feasibility and advisability of presoaking the aggregate prior to its use.

When carrying out these tests, the process and level of saturation to be reached shall be adjusted to reduce the variation in consistency between batches.

In the case of recycled concrete, the strength to be achieved in these tests to ensure that the characteristic strength of the work is satisfactory may be somewhat higher than expected with conventional concrete, taking into account the increase in dispersion of results due to a lack of uniformity of the recycled aggregate used. When carrying out tests, it is therefore advisable to use recycled aggregates of different qualities within permissible limits.

In elements particularly susceptible to strain or when using recycled aggregate percentages higher than 20%, it is advisable to include tests within the overall set of tests that determine properties such as modulus of elasticity, shrinkage and creep of concrete.

86.5. Inspection during construction

86.5.2. Inspection of the conformity of concrete workability during construction

Inclusion of recycled aggregates in concrete may lead to variations in consistency, even when the same water/cement ratio is maintained in the different batches due the different qualities of recycled aggregates. This effect is more pronounced in mixture with more than 20% of substitutions. In such cases, it is therefore recommended to presoak the recycled aggregate or to adjust the consistency in the work by adding plasticizing or superplasticizing admixtures following the concrete manufacturer's guidelines.

86.5.4. Statistical control of concrete strength during construction

For inspection purposes, the work should be divided in lots, being applicable the maximum limits laid down in this Code for the case of concretes with substitutions no greater than 20%.

The plant classification according to the production variation coefficient shall be carried out using only results from recycled concrete mixtures.

In elements with special responsibility or in the case of concretes with more than 20% of recycled aggregates, it is advisable to increase the inspection, reducing lots laid down in this Code and adopting those shown in the following table:

TABLE A.15.3
Recommended size of concrete batches with more than 20% of recycled aggregates or special elements

Upper limit	Structural element type		
	Compressed elements	Elements subject to simple bending	Massive
Concrete volume	50 m^3	50 m^3	100 m^3
Concreting time	2 weeks	2 weeks	1 week
Constructed surface area	500 m^2	500 m^2	-
Number of floors	1	1	-

In such cases, the inspection should be carried out determining the strength of N > 6 batches per lot.

86.5.6 Indirect control of concrete strength

For recycled concretes with more than 20% of recycled coarse aggregate, it is not advisable to use an indirect strength control.

A 22 Previous and characteristic test of concrete

A22.2 Compressive strength in characteristic test

The characteristic tests shall be carried out to check possible variations in concrete consistency and strength results due to the use of different recycled aggregate batches from the supply plant.

These tests shall also allow an adjustment in the mixing time, make it possible to check the effect of transporting time on consistency and evaluate the need to correct this in the work by adding plasticizing or superplasticizing admixtures following the manufacturer's guidelines.

For recycled concretes with a content of recycled aggregate no greater than 20%, the control procedures in the article are applicable.