ALKALI-AGGREGATE REACTION IN RECYCLED CONCRETE WITH AGGREGATES QUALIFIED AS REACTIVES BY THE ASTM C 1260 METHOD

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Abstract

The durability of concrete with recycled aggregates should conform to the intended life duration of the structures. Although there are sufficient experiences of resistant behavior of these concretes; their durability has not yet been studied in the depth it requires.

Many of its problems are associated with the original components of concrete demolition, the age of the demolished structure, the change of the type of structure and the content of the cement of the new concrete.

In this research paper two recycled concrete used as fine aggregate (characteristic of the constructions from Entre Rios) are studied. Aggregates are of basaltic origin and boulder from the Uruguay River.

The ASTM C 1260 method was used showing the remaining reaction potential of recycled aggregates, given some considerations that should not be neglected in order to ensure the durability of concretes made with this type of aggregates.

Keywords: concrete, alkali-silica reaction, recycled, durability.

1 INTRODUCTION

Nowadays the pressure in the building sector is increasing significantly to encourage the recycling of waste, both derived from its own activities as well as from other sectors. The most outstanding advantage of this recycling process is that it is the simultaneous solution of issues caused by the large amount of waste sent to landfill without exploitation as well as the production of a new raw material, which helps to reduce the extraction of primary natural resources.

In the recycling of construction materials, the recycled aggregates are the highest component, derived from the large volumes of waste from construction and demolition, all of which could be eliminated by using it. In some countries, the annual waste generation is one ton per inhabitant, 80% of them are disposed in landfills. The average rate for European recycling reaches to 40%.

In Argentina, despite the experience gained to the present, there is no specific legal framework for this type of aggregate. There have only been some individual initiatives and specific experiences aiming at foment the use of recycled aggregates.

The recycled aggregate still generates distrust and needs a more extensive control to ensure its compliance in different applications where it is used.

To obtain a suitable recycled aggregate, it is necessary to properly process the waste and make an extensive control of the input materials to the concrete manufacturing plant. Moreover, it is essential to develop appropriate processing techniques to ensure high quality material.

Concrete is a heterogeneous material which uses aggregates of different origin and characteristics in its composition and is also subject to influence from the environment where the construction work is located.

Prior to the application, it is necessary to evaluate the origin of the demolished concrete in order to prevent premature deterioration situations as a result of its composition and state or health. [1, 2]

These concepts shoulds be taken into account when dealing with recycled materials so as not to neglect the importance of the durability of concrete, in other words, to preserve in time the initial properties for which it had been designed, and ensure its useful lifetime [3, 4].

Deterioration leads to the need of investment on reparation before its time, having to replace the construction partially or entirely, lowering the credit attributed to the recycling of construction materials such as concrete.

The exploitation of natural aggregates deposits have changed the scenery due to its depression many areas, generating serious problems of environmental impact. Therefore, the recycling aggregates have become a valid alternative for the concrete production, considering that its characteristic mostly comply with the standard aggregates and the specified resistance. Its specified properties are different from the natural aggregate extracted from a river or quarry, so some of them may have to be controlled. Its origin involves a greater variety in the production, i.e. to add the recycled production to the natural aggregate. [5]

The elaboration of aggregate from recycled concrete is quite simple, since the machinery is similar to that used for the natural aggregate production and can achieve regular use concrete.They have greater absorption and dust, making it necessary to apply certain recommendations as the need to wash them previously and use them in saturated surface dry state to minimize problems in absorption of this material in dosage. [6, 7]

Concrete structures can suffer different pathologies. One of them is the ASR which is connected with the use of deleterious aggregates that react with the alkalis contained in portland cement concrete in the presence of humidity, causing technical and economic disadvantages in the constructions where it is used, putting in danger human lives or causing major repair expenses.

The recycled concrete affected by ASR or having in their composition potentially reactive aggregates, can develop the reaction in new concretes, this being due to the remaining reactivity in the first case or the change in the conditions of the mixtures, either due to the higher alkali content or the exposure of structures to humid environments.[8]

In this paper, we seek to analyze the behavior of recycled aggregates by assessing the likelihood of ASR development. We will make use of the ASTM C 1260 method, to say if the aggregates obtained by crushing portland cement concrete can be used or not, without the previous application of methodologies to prevent or minimize this reaction.

2 MATERIALS AND METHODS

2.1 Materials

To elaborate the mixes analyzed in this study, crushed aggregates from concrete with coarse aggregate either from basalt or from boulder were used, these being potentially reactive materials to the ASR, which had been part of concrete used in structures at height (buildings). (Table 1)

The aggregate obtained in the crushing has a rough texture and rounded particles (hammer crusher). Analyzing the physical properties that recycled concrete aggregates have in reference to the natural aggregates, clast composition stands out since a part of it is original rock and another part is a mortar. This causes a noticeable difference of water absorption, which, at times, highly surpasses the corresponding value for the natural coarse aggregate. The explanation for this phenomenon is that these clasts are composed of stony particles with mortar adhered to the surface as well as mortar particles only to, at this crushing level.

Mortar properties in fresh status were maintained in a small environment, workability in particular. Then, the crushing material was considered as a natural aggregate.

2.2 Methods for assessment and analysis

The methodology used to analyze the possibilities of development of ASR corresponds to the accelerated method ASTM C -1260 standard.

3 RESULTS

The expansion development by ASR of these recycled concrete has been represented in graphs, following the methodology of ASTM C 1260 (Figures 1, 2 and 3) (Table 2).

The slopes of the curves are the characteristicsobtained with natural aggregates.

In the photographs taken after the trial, cracks in test bars can be observed with the naked eye, as well as rosette-like gels from alkali- silica reaction by using the electron microscopy, (Figures 4, 5).

4 DISCUSSION

This photos makes it clear that these recycled materials show alkali- silica reaction in the accelerated method of ASTM C-1260.

The expansion values obtained in the case of crushed basalt (B1) are similar to the lowest values measured in the basalts of the region (Expansion values 0.3 to 0.7 in the region to ASTM C 1260).

In the case of boulder (CR1 and CR2) the values measured correspond to the highest measured values in boulders (Expansion values 0.03 to 0.13 in the region to ASTM C 1260).

5 CONCLUSIONS

In presence of potentially reactive aggregates in original concrete, the recycled concrete can develop the ASR, taking into account that the amount of highly soluble alkali provided by the new cement content is renewed.

It is necessary to know the remaining deleterious potential from recycled concrete or the aggregates it contains , prior to its use in new concrete.

In the case of crushed concretes studied in this research, it should be considered that they were from vertical concrete structures (high buildings) where they generally lack the humidity required to develop the alkali silica reaction.

Taking into consideration all the above mentioned, when crushed concretes are used as concrete aggregates, they should be considered as new aggregates and studied as such.

In the case of the ARS, it is recommendable to start by examining the change of destiny of the material with respect to the presence of constant humidity (from aerial structures to pavements). This is essential since these materials are generally recycled into pavements due to the fact that a high percentage of it can be recycled, making it very convenient.

6 REFERENCES

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TABLE 1 – Origin features of recycled concrete

<table>
<tr><th>Recycled Concrete</th><th>Fine</th><th>Coarse</th><td rowspan="4">FINE:
Fine aggregates are siliceous, being quartz the principal mineral, with minor amounts of opal and chalcedony. Together, the polymorphs of silica (quartz, chalcedony and opal) comprise between 85% and 95 % of the samples. The rest is composed of lithic clasts of basalt and sandstone, and minor amounts of feldspar, magnetite and other opaque minerals.

COARSE:
Basalt, given thee observed characteristics, can be classified as a tholeitico, hypo-crystalline Basalt, but with a very low proportion of altered volcanic glass (less than 5-7%). The total alteration of glass and the partial of clay minerals microphenocrysts (possibly smectite and/or illitesuggest the presence of a argillic alteration of mild type.
TheBoulders (gravel), although predominantly siliceous, show a marked difference in their mineralogical composition. Opal (20-40%) and chalcedony (15-25%) are the major fraction in respect to quartz and sandstone lithic clasts which are located in proportions higher than 10%.</td></tr>
<tr><td>B1</td><td>Silica Sand</td><td>Basalt</td></tr>
<tr><td>CR1</td><td>Silica Sand</td><td>Boulder 1</td></tr>
<tr><td>CR2</td><td>Silica Sand</td><td>Boulder 2</td></tr>
</table>

TABLE 2 -Results

Mix	Fine	Coarse	Expansion ASTM C-1260 (%)	
			to 16 days	to 28 days
B1	SilicaSand	Basalt	0.251	0.333
CR1	SilicaSand	Boulder 1	0.136	0.198
CR2	SilicaSand	Boulder 2	0.129	0.205

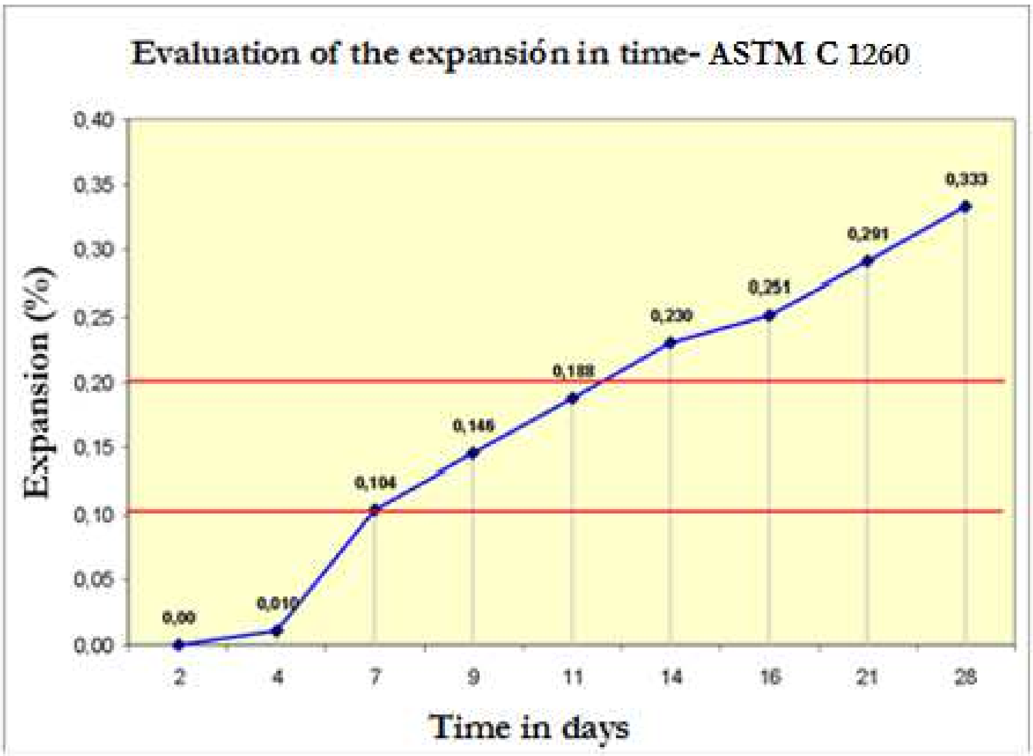

FIGURE 1 – Recycled B1-ASTM C-1260

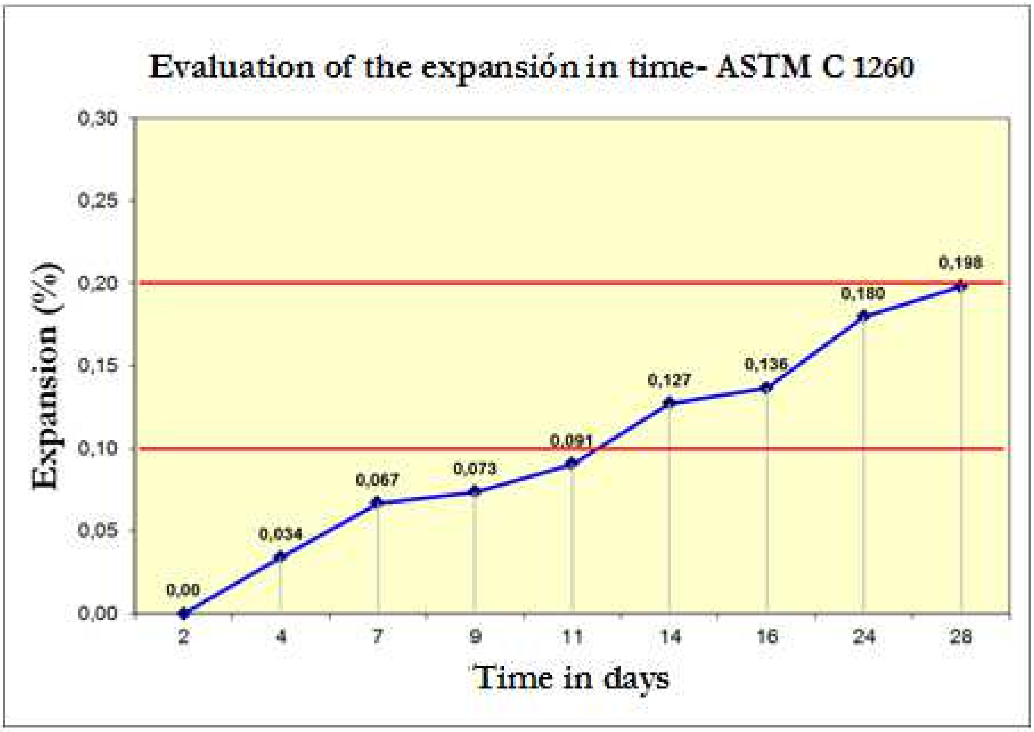

FIGURE 2 – Reclycled CR1-ASTM C-1260

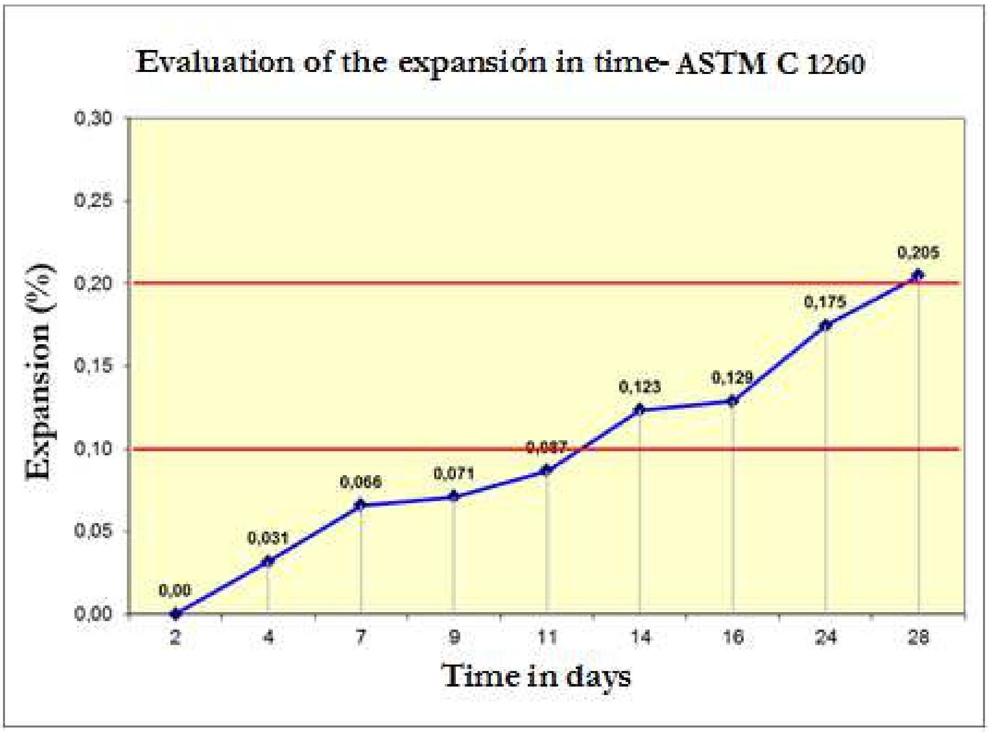

FIGURE 3 – Recycled CR2-ASTM C-1260

FIGURE 4: Cracking in mortar bar

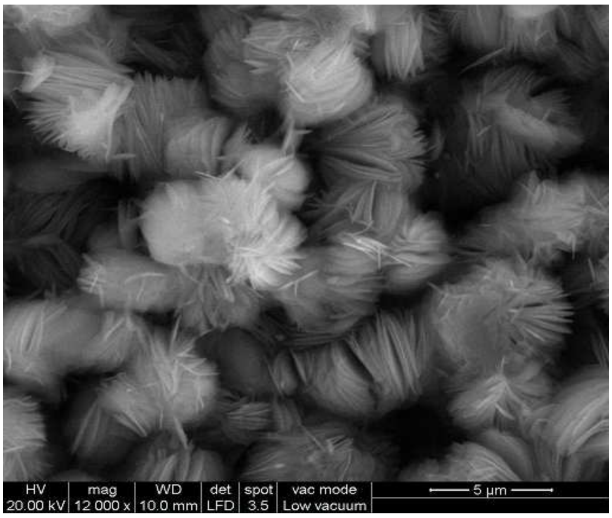

FIGURE 5: Rosette-like gels SEM (M B1)