







ORIGINAL ARTICLE

Incorporation of recycled aggregates from construction and demolition waste in paver blocks

Desempenho de blocos de concreto com incorporação de agregados reciclados provenientes de resíduos de construção e demolição

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Abstract: The consumption of natural resources and energy increased proportionally with the growth of the world population and its economic level. There was an increasing exponential consumption of natural resources, which implied an increase in environmental impacts. The construction sector is responsible for a very significant production of construction and demolition waste (CDW). Thus, there is a concern in search of a more sustainable final disposal. Many studies have been investigated the development of new materials with the incorporation of recycled aggregates from CDW. This paper presents a study of performance evaluation of concrete blocks produced with CDW. For that purpose, an experimental campaign was performed, including a characterization of the aggregates used. The incorporation of 100% of fine and coarse recycled aggregates. The mixtures were designed according to the condition of the aggregate (dry, washed or saturated). The performance of these blocks was evaluated in terms of mechanical strength and water absorption. Some additional tests were also performed to deeper analyze of the microstructure of these blocks. To assess the durability of the concrete blocks, a full-scale road was built. The results were very positive, since there were no significant differences between the modified concrete blocks and the reference sample (0% of the CDW). The modified block with fine aggregate presented the best performance of all the blocks, concerning mechanical strength. In addition, the performance of concrete blocks with washed recycled aggregates had a better performance compared to the others. The results obtained were satisfactory for the application of the blocks in the streets with low movement and low load.

Keywords: recycled aggregates, construction and demolition waste, paver blocks.

Resumo: O consumo de recursos naturais e energia aumentou proporcionalmente com o crescimento da população mundial e seu nível econômico. Houve um consumo exponencial crescente de recursos naturais, o que implicou em um aumento nos impactos ambientais. O setor da construção é responsável por uma produção muito significativa dos resíduos de construção e demolição (RCD). Dessa forma, evidencia-se uma preocupação em busca de destino final mais sustentável, com isso muitos estudos estão sendo feitos a fim de desenvolver novos produtos com a substituição de recursos naturais por RCD. Este trabalho pretende analisar o comportamento de blocos de concreto produzidos com RCD. Para isso, foi realizado um programa experimental, incluindo uma caracterização dos agregados utilizados. A substituição foi de 100% de agregados naturais miúdos e graúdos por agregados reciclados. As misturas foram projetadas de acordo com a condição do agregado (seco, lavado ou saturado). O desempenho destes blocos foi avaliado em termos de resistência mecânica e absorção de água. Alguns testes extras também foram formulados para entender a microestrutura desses blocos. Para avaliar a durabilidade dos blocos de pavimentação, foi realizada uma estrada em escala real. Os resultados da pesquisa foram muito positivos, uma vez que não houve diferenças significativas entre os blocos de concreto modificados e a amostra de referência (0% do RCD). Em termos mecânicos, o concreto modificado com agregado miúdo foi o que apresentou o melhor desempenho de todos

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os blocos. Além disso, o desempenho de blocos de concreto usando agregados reciclados lavados foi melhor em comparação com os outros. Os resultados obtidos foram satisfatórios para a aplicação dos blocos em ruas de baixo movimento e baixa carga.

Palavras-chave: agregados reciclados, resíduos de construção e demolição, blocos de pavimentação.

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1 INTRODUCTION

The construction industry has been considered one of the most waste producer and consumer of natural resources. This environmental concern encouraged the current trend of using recycled aggregates from construction and demolition waste for production of cementitious materials.

According to the Brazilian Association for Recycling of Construction and Demolition Waste (ABRECON) [1], in Brazil in the year of 2015 the estimated production of waste was approximately 85 million m³. The amount of recycled CDW was an average of 5 million m³.

The use of CDW as recycled aggregates is one of the most feasible solution. Several studies have been published about the use of recycled aggregate as replacement of natural sand. In this study, the performance of concrete blocks for interlocked paving with the incorporation of CDW as recycled aggregate is analyzed.

Researches have been developed to evaluate the use of recycled aggregates in concrete. From the literature, it can be verified that the materials produced with recycled aggregates achieve the required standards and specifications. Although, in some cases, there is a decrease in the mechanical strength. Particularly in the manufacture of concrete blocks [2]–[8], pre-cast cementitious products [9] and bricks [10].

Nonetheless, some authors have demonstrated an improvement on the mechanical properties of these materials with the use of recycled aggregate. Penteado et al. [11] observed an increase in compressive strength of the concrete blocks with recycled fine aggregates when compared to the reference blocks. Evangelista and Brito [12] justified these better results due the presence of non-hydrated cement particles in the recycled aggregate, which could contribute to a better bond between the cement paste and aggregates, due to their higher porosity. Rodriguez et al. [8] and Leite [13] studied the mechanical performance of concrete produced with recycled aggregates and obtained similar results.

On the other hand, the type of recycled aggregate affects differently the performance of the materials. Thus, Bravo et al. [14] highlighted an increase in impact resistance when coarse recycled aggregates were used in concrete blocks. Braga et al. [15] pointed out that the incorporation of fine recycled aggregates from CDW can increase the mechanical strength of the concrete due to the non-hydrated cement particles in the recycled material.

Bear in mind that the loss of mechanical strength is a limiting factor for the use of recycled aggregates, and it is higher when the water/cement ratio is lower [8], [16]. Notwithstanding the foregoing, some authors justified the increase of compressive strength in concrete with fine recycled aggregates due the pozzolanic effect of the fine particles [17], [18]

The higher content of fines in the recycled aggregates can improve the transition zone between the cementitious matrix and the aggregate, which contributes to a greater compactness of the concrete [19]. According to Lovato et al. [20] the fines particles provide a better packaging. As the recycled aggregate has higher absorption it promotes a greater adhesion between the cement paste and the aggregate, through the absorption of the paste and the precipitation of the crystals of hydration in the pores of the aggregate.

Another characteristic of the recycled aggregate that affects the concrete behavior is the presence of old mortar particles adhered to the grains. This could be related to a higher water absorption, higher porosity and lower resistance of the modified concrete [21]–[23].

In this research, the recycled aggregates were used in three different conditions, such as dried, washed and saturated. Rodrigues et al. [24] suggested to wash the aggregates to discard the fraction below 0.063mm, which can improve the quality of the recycled concrete produced. Poon et al. [25] recommended to saturate the recycled aggregate before mixing with the cement. This can reduce the water absorption of the aggregates.

Therefore, this research intends to analyze the performance of the concrete blocks with different conditions of the recycled aggregate.

1.1 Justification

Considering the environmental impacts, it has been developed several researches about the use of recycled aggregates from CDW. Therefore, this study presents a feasible product with the incorporation of recycled aggregate from CDW.

2 MATERIALS AND EXPERIMENTAL PROGRAM

2.1 Materials

The following materials were used in this research: cement, sand, additive and water.

2.1.1 Cement

The binder used was cement type CP II-Z-RS, mainly used for the precast industry. The physical, mechanical and chemical properties are presented in Table 1.

Table 1. Characteristics of CP II-Z-RS.

Physical characteristics	
Density (g/cm ³)	3.0
Blaine specif. area (cm ² /g)	4362
Initial set (min)	139
Final set (min)	191
Chemical characteristics	
Al ₂ O ₃	4.41
CaO	68.68
Fe ₂ O ₃	2.35
K ₂ O	1.26
MgO	2.70
SiO ₂	14.71
TiO ₂	0.33
SO ₃	5.48

2.1.2 Aggregates

Both aggregates (fine and coarse) were separated in terms of their size, by sieving. The recycled aggregates were collected according to NBR NM 26 [26], dried in an oven (105 ± 5 °C) for 48 hours and then cooled to the room temperature. After this procedure, they were submitted to the characterization tests. The fine fraction was sieved to remove particles over 4.75mm. The coarse aggregate was sieved to remove particles over 12.5mm and smaller than 4.75mm.

2.1.3 Additive

The additive used was SikaPaver HC-10.

2.2 Aggregates characterization

The characterization tests were performed for natural and recycled aggregates (fine and coarse). The physical tests: size distribution [27], dry bulk density [28], [29], water absorption by capillarity [30], abrasion resistance Los Angeles [31], the superficial area of the fines of the aggregates determined from the physical adsorption of the nitrogen on the materials by the Brunauer-Emmett-Teller (BET) method, these analyzes were performed by the BEL JAPAN model BELSORP-mini II.

The chemical analysis was performed by the EDX-720 X-ray fluorescence spectrometer Shimadzu in a vacuum atmosphere and the semi-quantitative method was developed. The micrographs were obtained from Hitachi model TM-3000.MEV equipment. The X-ray diffractogram was performed for the mixed recycled aggregate sample. The equipment used was Shimadzu model XRD - 7000. The specimen with a particle size of less than 0.15 mm were submitted to the test, using Cu - K α radiation, with accelerated voltage 40 kV and 30 mA current, with a 2 θ scan of 5 ° to 80 ° and speed of 5°/ min.

2.3 Mixes proportions

Table 2 presents the mortars specification. Table 3 shows the mixes compositions.

Table 2. Mixes' composition.

Mixes	Mixes' composition	Recycled Aggregates Condition
FNCN	Fine Natural Aggregate + Coarse Natural Aggregate	-
FNCRD	Fine Natural Aggregate + Coarse Recycled Aggregate	Dried
FNCRW	Fine Natural Aggregate + Coarse Recycled Aggregate	Washed
FNCRS	Fine Natural Aggregate + Coarse Recycled Aggregate	Saturated
FRCND	Fine Recycled Aggregate + Coarse Natural Aggregate	Dried
FRCNW	Fine Recycled Aggregate + Coarse Natural Aggregate	Washed
FRCRD	Fine Recycled Aggregate + Coarse Recycled Aggregate	Dried
FRCRW	Fine Recycled Aggregate + Coarse Recycled Aggregate	Washed

Table 3. Mix proportions of concrete (kg/m³).

Mixes	Cement	Water	Natural sand	Recycled sand	Natural gravel	Recycled gravel
FNCN	199.7	76.8	1716.8	-	533.8	-
FNCRD	197.4	75.9	1696.8	-	-	440.3
FNCRW	197.4	75.9	1696.8	-	-	440.3
FNCRS	197.4	75.9	1696.8	-	-	440.3
FRCND	198.6	76.4	-	1649.6	530.8	-
FRCNW	198.6	76.4	-	1649.6	530.8	-
FRCRD	196.3	75.5	-	1630.6	-	437.9
FRCRW	196.3	75.5	-	1630.6	-	437.9

It was investigated the use of fine and coarse recycled aggregates under three conditions: dried, washed and saturated. In order to verify the influence of its condition on the properties of the concrete blocks produced.

Dried condition: the recycled aggregates were introduced into the mixture as they are produced in the plant.

Washed condition: the recycled aggregates were washed for removal of the pulverulent material, the sieve used in the wash was #200 (0.075mm). After that the recycled aggregates were dried before adding in the mix.

Saturated condition: the recycled aggregates were immersed in water for 24 hours before being mixed for the production of the blocks. However, the saturated fine recycled aggregates did not obtain the required consistency, discarding this possibility. Thus, only the recycled coarse aggregates were saturated.

2.4 Tests

The production of the blocks was performed in a real scale inside a precast plant. The dimensional tolerance analysis of the blocks was according to NBR 9781 [32]. The standard refers to the dimensions of the block as 10x20x6cm (width x length x thickness), admitting 3 cm of tolerance.

The compressive strength was evaluated at the ages of 7, 14, 28 and 365 days with six blocks for each sample, according to NBR 9781 [32]. The standard requires that two auxiliary boards for the compressive strength test must be circular, with a diameter of 85 mm and a minimum thickness of 20 mm, made of steel.

Water absorption at 28 and 365 days with three blocks of each composition was analyzed. For the analysis of water absorption, the test was carried out according to NBR 9781 [32].

2.5 Evaluation of real-scale interlocked blocks

To evaluate the performance in the field, a real-scale experimental stretch of interlocked paving was performed with the blocks produced. The prototype was built in the Recycling Plant, which provided the recycled aggregates. The segment was divided into parts for evaluation of each composition, in order to analyze the functional performance of the blocks.

3 RESULTS AND DISCUSSIONS

3.1 Aggregates characterization

Figure 1 shows the size distribution curve of the sand. The recycled sand presented a curve of differentiated size of particles, which enhance the packaging.

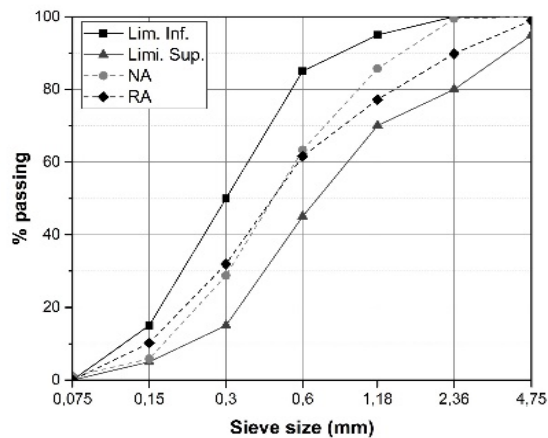


Figure 1. Size distribution of natural and recycled fine aggregate. NA = Natural Aggregate. RA = Recycled Aggregate.

The size distribution of the coarse recycled aggregate is similar to that the natural aggregate, as can be observed in Figure 2. The compactness of the concrete affects directly the mechanical behavior. It can be observed that the recycled sand presents a better size distribution, which could improve the mechanical resistance.

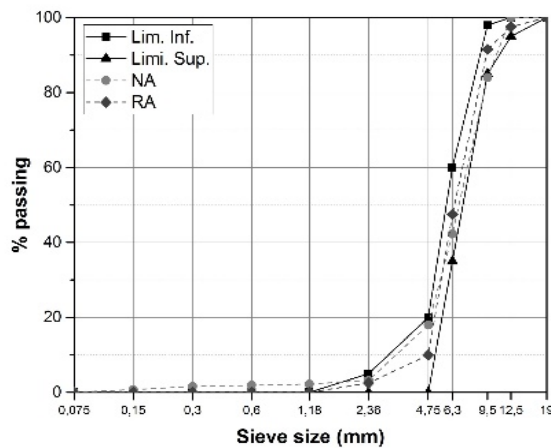


Figure 2. Size distribution of natural and recycled coarse aggregate. NA = Natural Aggregate. RA = Recycled Aggregate.

Table 4 shows the results of the physical tests of natural and recycled fine aggregates. The density of the recycled aggregate is lower when compared to the natural aggregate, while the water absorption has significantly higher values. These characteristics, in general, are attributed to the old mortar adhered to the particle [21], [22], [33].

Table 4. Fine aggregates characteristics.

	Natural Sand	Recycled Sand
Fineness Modulus	2.17	2.27
Bulk density (kg/m ³)	1490	1440
Dry density (kg/m ³)	2620	2510
Fine content (%)	1.00	7.00
Surface area	1.227	3.547

In general, recycled aggregates present lower density than natural aggregates. This fact could be attributed to their heterogeneity due to the waste's composition. Thus, the density of the recycled materials tends to be lower than those of conventional mortar and concrete [8].

According to the standard for determining the content of powdery materials in aggregates (NBR 7219) [34] the maximum values of materials passing through the 0.075mm sieve is 5%. A higher content of fine particles in the mix can affect the required kneading water, which implies a reduction in the mechanical resistance of the concrete produced, as well as, a decrease in abrasion resistance [35]. This may affect negatively the concrete, due to the higher water consumption and the presence of clay minerals.

In this research, the recycled fine aggregates obtained 7% of particles passing through the #200 sieve. This amount of dust can affect the bond between the aggregate and the paste, which may weaken the transition zone. Washing is a technique used to remove the pulverulent material from the recycled aggregates, since the content of fines correlates directly with the water absorption of the aggregates, due to the greater surface area of the materials. The reduction of the very fines particles decreases the water/cement ratio, which can influence the workability and improve the properties of the hardened concrete.

The results obtained in the laser granulometry (BET) test for the fines material showed the recycled aggregates with greater surface area, corroborating with other studies [19], [36]. This could be explained by a surface more irregular and porous. As a consequence of this, the recycled aggregate can provide a strengthening of the interfacial transition zone between the cementitious matrix and the aggregates.

Table 5 presents the results of the tests performed with the coarse aggregates. The Los Angeles abrasion resistance analyses the quality of the material. It is identified the resistance to fragmentation by shock and friction of the particles. The resistance of the recycled aggregate is not the same as the material that originated it, because the crushing process weakens the particle, which causes the cracks inside the recycled aggregate.

Table 5. Coarse aggregates characteristics.

	Natural Gravel	Recycled Gravel
Bulk density (kg/m ³)	1390	1160
Dry density (kg/m ³)	2610	2060
Fine content (%)	1.00	4.00
Los Angeles	25	49
Water absorption (%)	1.00	8.00

Table 6 shows the chemical analyzes of the natural and recycled aggregates.

Table 6. X Ray fluorescence test results.

Samples	Al ₂ O ₃	CaO	Fe ₂ O ₃
NA	12.10	4.65	8.99
RA	10.18	29.80	8.90

NA = Natural Aggregate. RA = Recycled Aggregate.

The recycled aggregates present a chemical composition similar to that found in other studies that analyzed the recycled aggregates [22], [37], [38].

The main elements found in the recycled aggregates are oxides of silica, calcium, aluminum and iron, originating mainly from hydrated cementitious compounds (concretes and mortars), as well as materials of ceramic origin [39]. It is important

to highlight the presence of sulfur oxide (SO₃) in the recycled aggregate, since this chemical element can cause gradual loss of mechanical resistance and affect the durability of materials produced with this type of aggregates [40].

The results of the images obtained by SEM for the natural and recycled aggregates are shown in Figures 3 and 4.

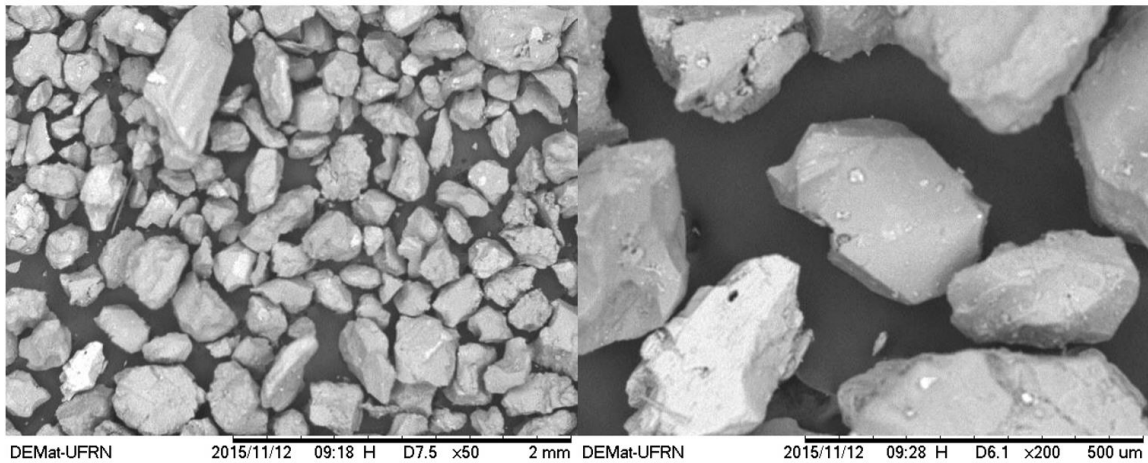


Figure 3. SEM image of obtained natural aggregate sample.

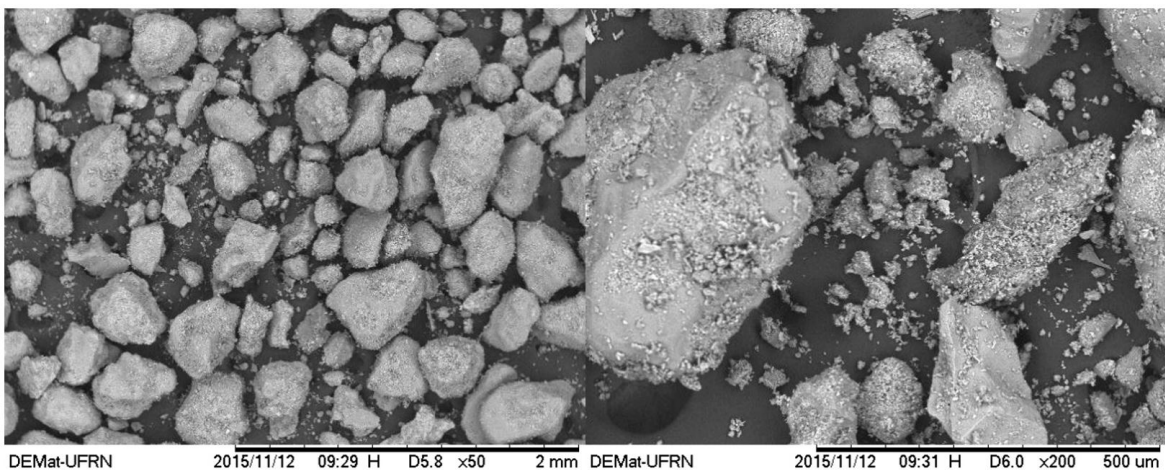


Figure 4. SEM image of obtained recycled aggregate sample.

The particles of the natural aggregates present regular texture and size. However, the recycled aggregates present irregular shape and size, with more defined edges, which can be attributed to the CDW crushing process to obtain these aggregates.

The particles of the recycled aggregates also present a roughened porous surface, which may be due to the old mortar adhered to the particles, corroborating with the micrographs presented by other authors [23], [41], [42]. The rough surface of the particle can improve the adhesion between the particles and the cementitious matrix, increasing the mechanical resistance.

Figure 5 shows the main crystalline phases of the recycled aggregate. In agreement with the results of the chemical composition, the recycled aggregate presents silicates (quartz; feldspars-albite and microcline; mica-muscovite and clay mineral-kaolinite), sulfates (gypsite) and carbonates (calcite).

The mineralogical composition of the recycled aggregate originated from the variety of original components (concrete, mortar, and ceramics), and is consistent with other published studies [10], [23], [24], [27], [39], [40].

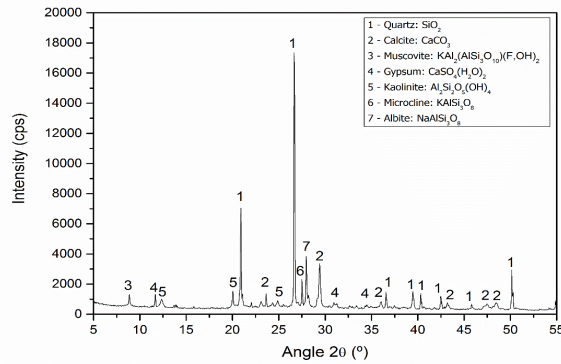


Figure 5. Diffractogram of the recycled aggregate.

3.2 Blocks characterization

Table 7 present the results obtained of water absorption and compressive strength of the concrete blocks. These results are discussed individually in the following sections.

Table 7. Properties of concrete blocks.

Samples	Water absorption (%)				Compressive strength (MPa)							
	28 d	SD	365 d	SD	7 d	SD	14 d	SD	28 d	SD	365 d	SD
FNCN	28 d	SD	365 d	SD	7 d	SD	14 d	SD	28 d	SD	365 d	SD
FNCRD	4.0	0.1	2.0	0.14	10.97	0.25	11.6	0.88	13.12	0.87	18.1	0.33
FNCRW	7.0	0.48	6.0	0.24	7.41	0.69	9.26	1.01	9.72	0.77	14.28	0.55
FNCRS	6.0	0.158	5.0	0.38	9.11	0.38	10.66	0.98	12.22	0.54	16.58	0.48
FRCND	8.0	0.25	5.0	0.54	8.2	0.54	10.6	0.65	13.56	0.59	19.23	0.59
FRCNW	3.0	0.36	2.0	0.41	11.57	0.87	12.96	0.67	15.2	0.67	24.35	0.77
FRCRD	4.0	0.58	3.0	0.33	15.71	0.59	17.35	0.77	22.16	0.55	27.34	0.99
FRCRW	6.0	0.12	5.0	0.21	9.85	0.25	10.29	0.88	11.13	0.34	15.34	1.05

Legenda: d = days; SD = Standard deviation

3.2.1 Water absorption

The Brazilian standard NBR 9781 [32] based on ASTM C 936-1 [43], requires an average water absorption results of less than or equal to 5%, with individual values not exceeding 7% being accepted. Figure 6 shows the values of the absorption rate of the blocks at 28 and 365 days.

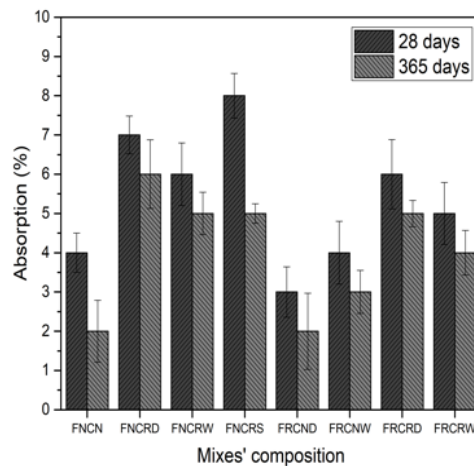


Figure 6. Absorption of water from the blocks at 28 and 365 days.

The samples with dried recycled sand and natural coarse aggregate obtained the lowest rate of water absorption at 28 days. The recycled sand with high powder content may have caused a better packaging of the particles in the concrete, which contributes to a better compactness of the block. The continuous size distribution of recycled sand may have influenced a lower rate of water absorption.

At 28 days, the concrete blocks produced with washed recycled aggregate achieved the requirements of the standard, obtained the water absorption rate less than or equal to 5% beyond the reference. On the other hand, the blocks produced with natural sand and recycled coarse aggregates obtained an average water absorption higher than 5%.

The reference block had the lowest volume of voids and, consequently, the highest density. Blocks with natural sand and dried coarse recycled aggregate showed a higher absorption rate as greater voids indices. However, the block with natural sand and washed coarse recycled obtained a lower rate of water absorption. It is emphasized that the washing procedure changed the water absorption rate of the block with coarse recycled aggregate.

The blocks produced with recycled sand presented water absorption similar to the block with natural aggregates. As for the blocks with washed fine recycled aggregates, it was observed that they obtained higher absorption results than the blocks with dried recycled.

3.2.2 Compressive strength

Figure 7 shows the results obtained in the compressive strength of all specimens at 7, 14, 28 and 365 days. The best mechanical strength at 28 and 365 days was the modified concrete produced with washed recycled sand and natural coarse aggregate.

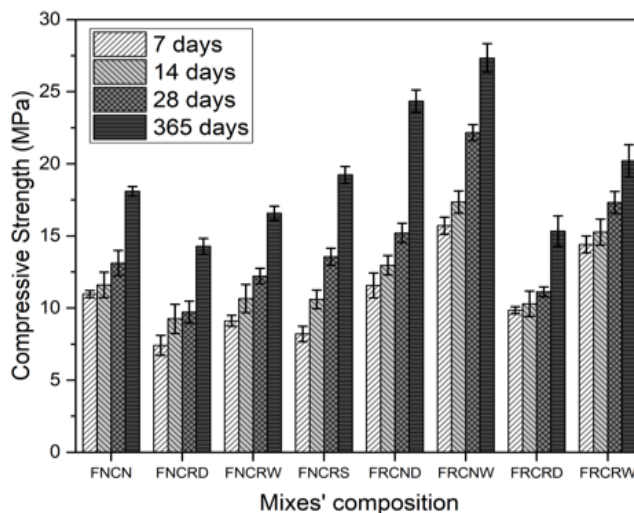


Figure 7. Comparison of the compressive strength of the blocks tested.

Blocks with recycled sand presented a better mechanical performance compared to the reference concrete block. Vieira and Dal Molin [44] also followed the same trend. There was an increase in the compressive strength with 100% recycled sand and 0% recycled coarse aggregate. This better performance could also be attributed to a chemical factor due to a possible pozzolanic effect of the very fine material.

Figure 8 presents the results of the compressive strength of the blocks by the fine and coarse aggregates used. Figure 8 shows the increment in compressive strength of the blocks produced with fine recycled aggregates when compared to the others.

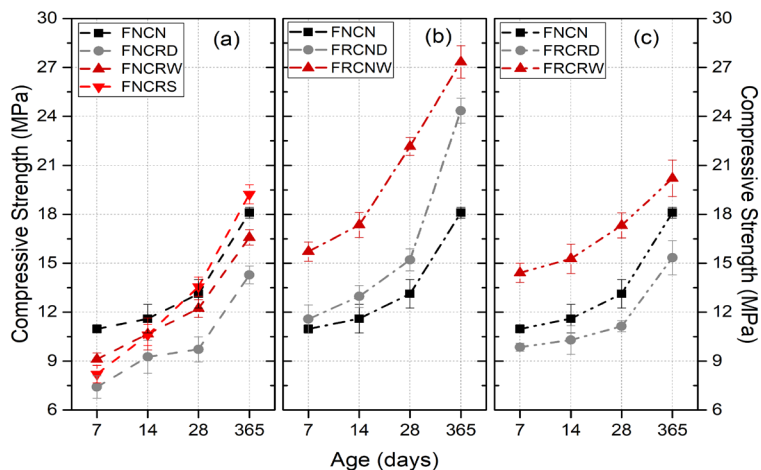


Figure 8. Compressive strength of the blocks tested by fine and coarse aggregates.

Leite et al. [45] also found that the concrete blocks with fine recycled aggregates presented pozzolanic activity indexes, which may be associated to the increase of compressive strength in concretes with high content of sand replacement at advanced ages. Khatib [17] verified the increase of compressive strength from 28 to 90 days in concrete with fine recycled aggregate and justified this effect by the possible pozzolanic activity of the fines.

Cabral et al. [19] also verified that the use of the fine recycled aggregate increased the compressive strength of the concrete. Possible reasons for this effect were the pozzolanic reactions, which improve the interfacial transition zone of the matrix, the roughness of the particles. It reinforces the bonds between the cement paste and the aggregates, and the water absorbed by the particles may be available for continuous hydration of the cement. These results were also pointed out by other authors [12], [18], [46].

In general, the mechanical strength present significant improvements with the incorporation of fines, due to both the filler effect, due to a filling of voids by the very fine particles, which increase the compactness of the concrete. Braga et al. [15] pointed out that with the replacement of fine aggregate, in addition to the filler effect, it occurs the hydraulic effect of non-hydrated cement on the recycled material. Thus, the strength may depend on the type of fines and the amount of replacement.

From the results obtained in this research and from other authors [20], [47] it is evident that the use of recycled aggregates in concrete does not significantly affect the compressive strength. However, it is essential to consider the characterization and treatment of recycled aggregates. Leite et al. [45] found that the use of recycled aggregate in concrete replacing the natural aggregate, mainly for low water/cement ratios is feasible.

The concrete produced with coarse recycled aggregates presented a decrease of compressive strength when compared to the reference blocks. At 365 days, obtained reduction of 21% and 8%, with dried and washed aggregates, respectively. Vieira and Dal Molin [44] and Poon and Chan [2] also found a reduction of mechanical resistance with the replacement of 100% of coarse recycled aggregates.

For the manufacture of precast concrete a lower water/cement factor is required, which may present difficulty in the workability of the mixture. Thus, it is necessary to take into consideration that recycled aggregates can absorb part of the kneading water. Thus, the decrease of mechanical strength with recycled aggregate can be attributed to the water/cement ratio, the higher water absorption and the lower density of the recycled aggregates.

The performance of the concrete with recycled aggregate depends mainly on the cement consumption and the water/cement ratio. The decrease of compressive strength can be attributed to factors such as low resistance and density of the recycled aggregate and higher water absorption, which implies negatively in the workability and consequently in the mechanical resistance.

3.2.3 Analysis of the experimental section

The interlocking pavement road was analyzed after one year of being used. In general, the pavement indicated good functionality and its in use, supporting the demanded load.

Visually, in the reference blocks can notice no evidence of broken edges. The blocks produced with recycled fine aggregate also exhibit similar behavior as the reference block. However, blocks produced with coarse recycled aggregate presented higher damages.

In order to evaluate the mechanical performance of the specimens, the compressive strength was analyzed in blocks with total replacement of fine and coarse recycled aggregates (FRCRD / FRCRW), the results are presented in Figure 9. It was observed a reduction in the mechanical performance. Blocks produced with dried recycled aggregates obtained an average of 9.87MPa, a reduction of 34.2% when compared to the results obtained of the same samples kept 365 days inside the laboratory conditions.

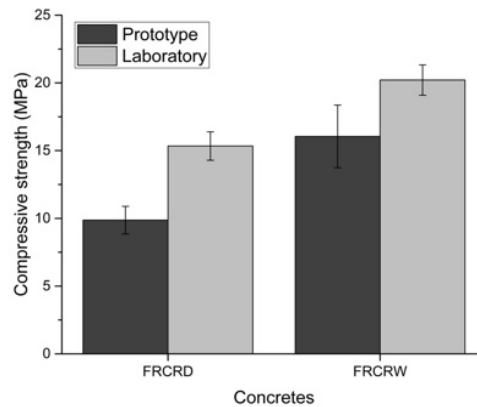


Figure 9. Comparison between the compressive strength of the blocks produced in the laboratory and in the field.

The blocks produced with washed recycled aggregates presented a compressive strength of 16.05MPa, which means a reduction of 27% according to the resistance at 365 days. The decrease in mechanical strength can be attributed to the load borne by the parts during this period. In general, the pavement indicated good functionality and is in use in the plant itself, supporting the demanded load.

4 CONCLUSIONS

Modified blocks with the incorporation of recycled sand presented a better performance comparing to the reference concrete. On the other hand, blocks with the incorporation of coarse aggregates presented several drawbacks.

Blocks produced with washed recycled aggregates presented better results in all properties. The removal of the powdery material provided greater compressive strength.

The visual aspects of the modified blocks in the experimental full-scale presented slightly more damaged than the reference blocks.

Blocks produced with recycled aggregates could be used for low-load road, such as sidewalks, gardens and streets.

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