Waste And By-Products Recycled For Concrete

Bourmatte Nadjoua, Houari Hacene

Abstract: The industry of building materials is always accompanied by secondary products or waste which have an incidence on the environment. The management of solid waste is one of main environmental concerns in the world. With the rarity of the space of discharge, the use of waste became an interesting alternative in the elimination ; the research is led on the use of waste and concrete products, it is not only economic, but also help to reduce the problems of elimination, the research program thus includes the works concerning the valuation of the waste of construction/demolition and under products, as well as on the development of new materials and products : mortar or concrete with these recycled aggregates. We present in this article the results of a vast experimental program dedicated to the study of a variety of mortars and concretes with substitution aggregates waste (of construction / demolition) and under products. We chose as basic parameters:

- The origin of the waste (of bricks) or of (concrete of demolition)
- The substitution rate recycled aggregates : 0% - 25% - 50% - 100%
- The variation of the dosage in cement: 250 - 350 and 450 Kg / m³.

By studying these parameters, we were able to observe the behaviour to the state of fresh and hardened various materials developed with the recycled aggregates. The recycled concrete aggregates are generally more absorbent and less dense than the ordinary aggregates.the shape of aggregates is similar to that of the crushed stone. Concretes made with aggregates resulting from the recycling present good qualities of handiness, durability and resistance in the action of the freeze-thaw. the compressive strength varies according to the initial resistance and the relationship water/cement of the new concrete. As for any new source of aggregates, it is necessary to control the durability, the sise grading and the properties of aggregates.

Keywords : recycled aggregates, waste, brick,concrete demolition, recycled aggregate concrete

I. Introduction

Constraints of ecological and economic impose increasingly need partial replacement of conventional materials used in the building and public works by local materials substitution. In this context, the aggregates from demolition products, waste and industrial by-products (recycled aggregates) are of particular interest because their valuation is one way that solves many of the environmental problems in the storage waste and simultaneously the preservation of natural aggregate deposits. As no decrease in safety is acceptable, studies on the durability of concrete containing recycled aggregates prove an essential step to assign a domain user. Our work is a continuation of research that has highlighted the possibility of using recycled aggregates from demolition and waste products produced industrially in hydraulic concrete. Management of solid waste is a major environmental concern in the world. With the scarcity of landfill space and cost because of its increasingly high, the use of waste has become an attractive alternative to disposal. The research is conducted on the use of waste concrete products. These products include a general way, the concrete demolition waste, discarded tires, plastic, glass, steel, foundry sand burned, coal combustion byproducts, waste brick and marble, each of these waste has a specific effect on the properties of fresh and hardened concrete. Sustainability can be defined as maintaining the qualities of concrete over a long period, that is to say its capacity over time to resist some attacks from chemical, physical or biological.

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Our work devoted to including recycled aggregate concrete is primarily concerned with sustainability for current uses. However, to ensure satisfactory durability for this type of concrete, it is not enough, as for conventional concretes, define the environmental conditions of the structure, disorders can be caused by internal factors, depending on the composition chemical and mineralogical recycled aggregates. Research on the compatibility of the composents of these aggregates are also needed. The concrete will always be the building material most commonly used in the future, as in the case of other industries, the universal need to conserve resources, protect the environment and make good use of energy must necessarily be felt in the field of concrete technology, therefore, we give great importance to the use of construction waste / demolition (concrete demolition) for the manufacture of concrete and brick waste for the manufacture of mortars. Currently, recovery of demolition waste has passed the stage of experimentation in the world and its development is quite large and the rate of recycling of construction debris / demolition in some countries has reached 80%. The research program therefore includes work on waste recycling construction / demolition, as well as the development of new materials and products (concrete based on recycled aggregates) with integration of algerien raw materials.

II. EXPERIMENTAL MATERIALS AND PROCEDURES

II.1.Materials

II.1.1.Cement

The cement used in the study of concrete is a CPJ 45 manufactured at the El-Hamma (Constantine), while that used for the preparation of mortars is a CPJ 32.5 which comes from the region of Ain El -Kebira (Setif).

II.1.2.Standard sand
Mortars are made with standard sand CEN EN 196-1, the true density is 2640 kg / m³.

II.1.3. Waste bricks
The development of aggregates made by operations: crushing, screening and storage. Characteristics of the sand from waste brick are presented in **Table 1**.

Table 1. characteristics of the waste sand brick

Test	Value
Equivalent sand	Class 0/5 : 87% > 65%
Blue test Méthylène	Class 0/5 : 0.33 < 1
Absolute density	2.21 t/m³
Percentage of carbonate	CaCo3 : 8.81%

II.1.4. Recycled aggregates (concrete demolition)
From specimens that have undergone laboratory destructive tests and has information on the composition and dosage of their concrete, aggregate quality and characteristics, the development of aggregates also by three operations: crushing, screening andstorage. The gradings are obtained: Recycled Aggregates: Sand 0/6, Gravel 6/12, Gravel 12/20, The characteristics of these aggregates are presented in **Table 2**.

Table 2. characteristics of concrete demolition aggregates

Class / Test	Class 0/6	Class 6/12	Class 12/20	Limit value
Kurtosis		11%	14%	<30%
Equivalent sand	95%			>65%
Méthylène blue	0.38			<1
Bulk density	1.35	1.24	1.23	
Los Angeles test		27%	25%	<40%
Micro-Deval test		31%		

II.2. Composition parameters and experimental procedures

II.2.1. variable parameters
- Rate of substitution of recycled aggregates (concrete demolition): 0%, 25%, 50% and 100% respectively to achieve concrete BR0, BR25, BR50 and BR100.
- Rate of substitution of aggregates recovered

(waste brick): 0%, 25%, 50%, 75% and 100% respectively to make mortars M0, M25, M50, M75 and M100.
- Dosage cement: 250, 350, 450 Kg / m³.

II.2.2. Fixed parameters:
- The workability of concrete.
- The water / cement ratio of the mortar: W / C = 0.5 The composition of concrete is made using the "Dreux Gorisse" method which represents the synthesis of a variety of formulations and provides better resistance and handling acceptable.

For the formulation of concrete BR100: aggregates are crushed three classes, sag Abrams cone is 6 to 9, after plotting the particle size, we obtain the percentages of the three aggregate absolute volume: 0/6 .... 46%, 6/12 .... 22%, 12/20 .... 32%. For concrete BR0: crushed aggregates are four classes, the collapse is 6 to 9, according to the grading curves plotted the percentages of aggregate absolute volume are determined: 0/3 .... 34%, 3/8 ... .9%, 8/15 .... 16%, 15/25 .... 42%. The composition of the mortar is made by adopting the formulation of a normal mortar, the mortar is carried out according to EN 1961, these constituents are wasted in the following proportions: 450g ± 2g cement, 1350 ± 5g of standard sand, 225g ± 1g of water. Cylindrical specimens of size 16X32 Cm are made to measure the compressive strength of concrete, and other prismatic dimensions 7X7X28 Cm for determining the tensile strength of concrete, and 4x4x16 Cm for study of mortars. The test pieces are stored in water at a temperature of 20 ° ± 1c to the maturity of rupture.

III. Results and Discussions

III.1. Study of concrete

III.1.1. Density of fresh concrete
The density is derived by applying the following test formula: ρ = (p-p0) / V, where p is the mass of the container full of concrete, one of the empty container p0 and V its volume. As a general curves **(Figure 1)** show that densities are decreasing with the degree of substitution of recycled aggregates (concrete demolition).

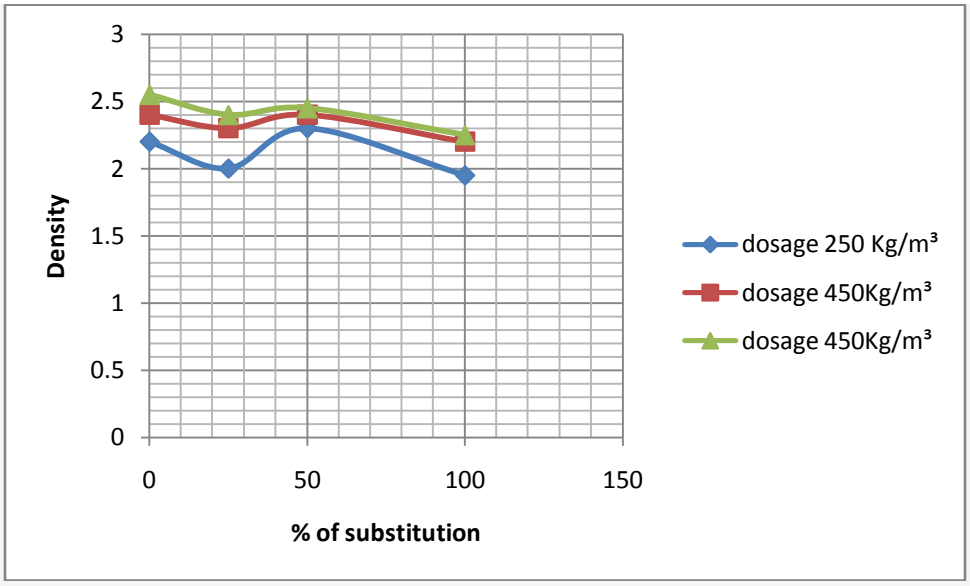

Figure 1. Variation of the density of fresh concrete in the rate of substitution

This decrease can be explained logically due to the higher porosity and light impurities present in these aggregates, in addition to the low density of the cement matrix **[2],** we can also notice that the densities of concretes based on these aggregates are lower than those of concretes containing natural aggregates. For a rate of 100%, the density decreases to 1.95.

III.1.2. entrapped air

The principle of the measurement of entrained air depends on the compressibility of air bubbles in fresh concrete and application of the law of Mariotte, this t test are performed with a hydrometer Concrete according to NF P18 353 The porosity is characterized by gapping, the percentage of these voids affects the amount of air in the concrete.

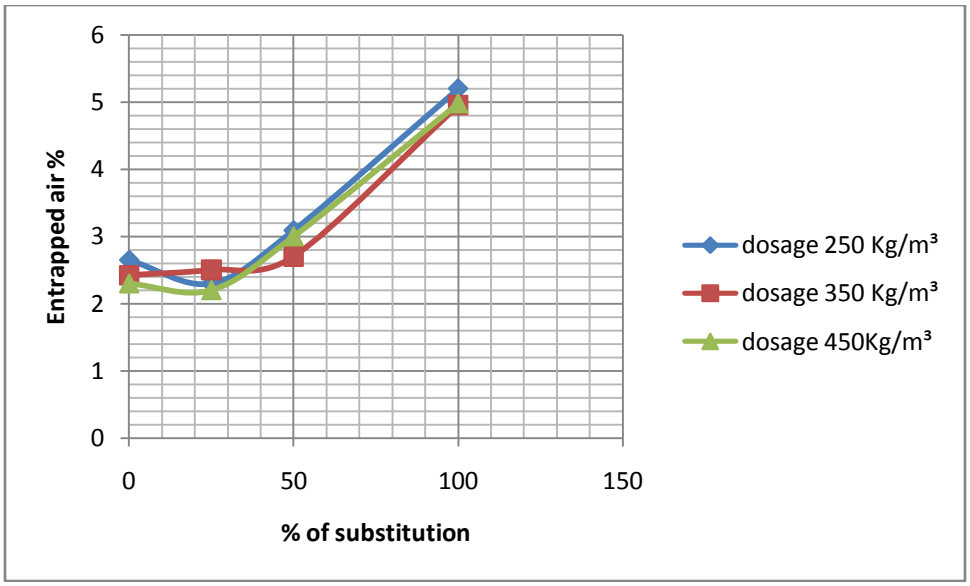

Figure 2. entrapped air concrete depending on the rate of substitution

According to the curves **(Figure 2)** entrapped air increases with the degree of substitution, it reaches its maximum value 5.20% for concrete containing 100% recycled aggregates and decreases when the cement content increases, because hydrating cement is gradually filled pores.

III.1.3.Water demand

This test is performed using the Abrams cone according to NF P18 451, the water demand is defined as the effective dosage of water necessary to obtain the desired consistency, the results of the influence of the substitution rate on demand concrete water made for a constant workability are presented in the following graphs **(Figure 3)**

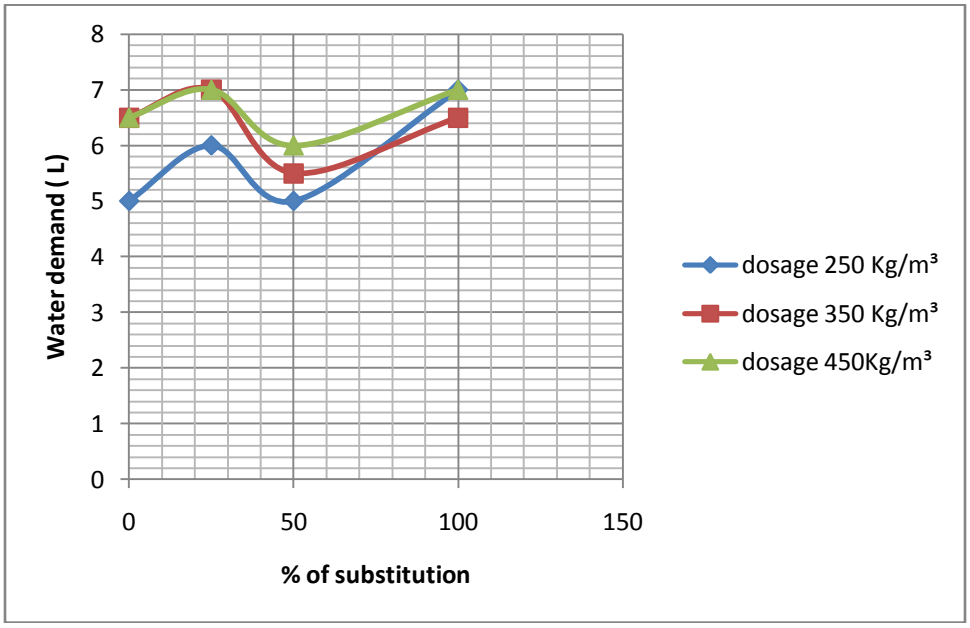

Figure 3. water demand of concrete depending on the rate of substitution

It can be seen as one might expect that the water demand of concrete containing recycled aggregates is higher than that of ordinary concrete, the difference can be explained by the absorption of a portion of the mixing water by recycled aggregates, the absorption can be attributed largely to the presence of old mortar attached to primary aggregates, which creates a high porosity of recycled aggregates **[2]**.

III.1.4. mechanical strength Figure 4 shows the compressive strength at 28 days depending on the degree of substitution of recycled aggregates.

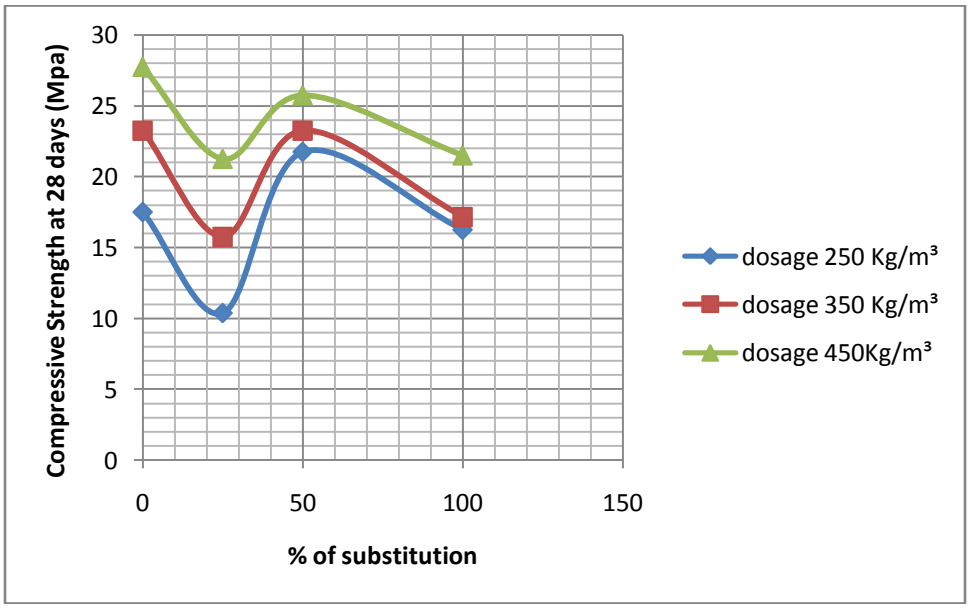

Figure 4. Varying the compressive strength of concrete at 28days according to rate of substitution

Note that the curves are distinct and from 50%, the curves are closer. The BR0 concrete has the best compressive strength. The compressive strength of concrete decreases as the percentage of recycled aggregates increases, it can increase by increasing the cement **[3].** Indeed, it has been shown that the water / cement ratio is the most important factor that determines the compressive strength of concrete, as well as the texture, shape and hardness of the aggregates. The adhesion between mortar and coarse aggregate influences the compressive strength, which reflects the decrease in the strength of concrete with recycled aggregates. The curves in **Figure 5** show the influence of the degree of substitution of recycled aggregates on the effort applied to the flexural tensile test.

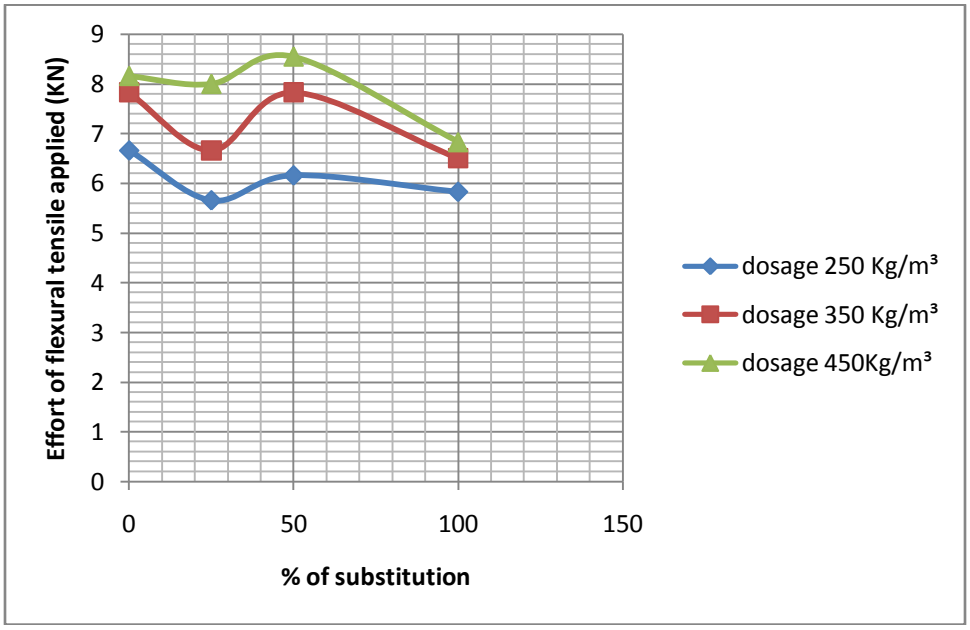

Figure 5. variation of the tensile strength of concrete at 28j according to substitution rate

The values represented of these efforts are arithmetic averages of the different values for each test. The lowest values of tensile strength is obtained in the concrete BR100 The maximum bending stress applied to the flexural tensile test is 8.55 KN obtained in concrete BR50.

III.2. Study of mortars

III.2.1. Compressive strength

In **Figure 6**, the compressive strength Cs of different mortars are shown as a function of substitution rate of waste sand brick maturities: 2,7 and 28 days

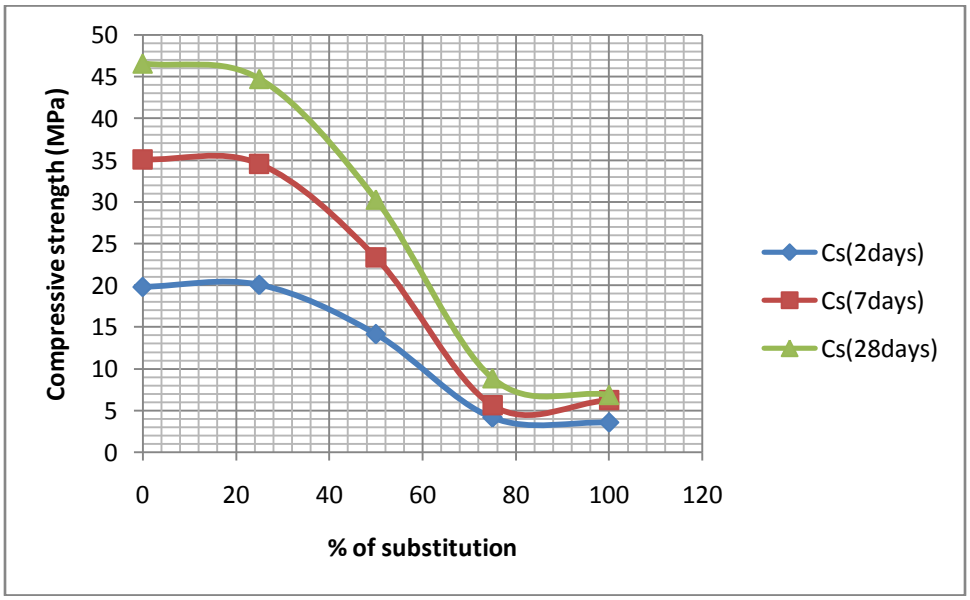

Figure 6. Variation in compressive strength of the mortars according to the degree of substitution

Note that the compressive strengths of different mortars increase over time. A mortar based on standardized waste sand and brick M25 has the best resistance to compression (identical to those of normal mortar) It can be observed that after 28 days, the compressive strength of mortar is considerable with a degree of substitution of waste sand brick25%. We can say with a degree of substitution of 100%, the compressive strength loss in a big way, this can be attributed to the low adhesion between the cement paste and sand waste bricks and the strength and hardness of the sand particles, is to say its ability to withstand the stresses applied to it.

III.2.2. Tensile strength

The variation of tensile strength Ts as a function of a percentage of waste sand bricks is shown in **Figure 7.**

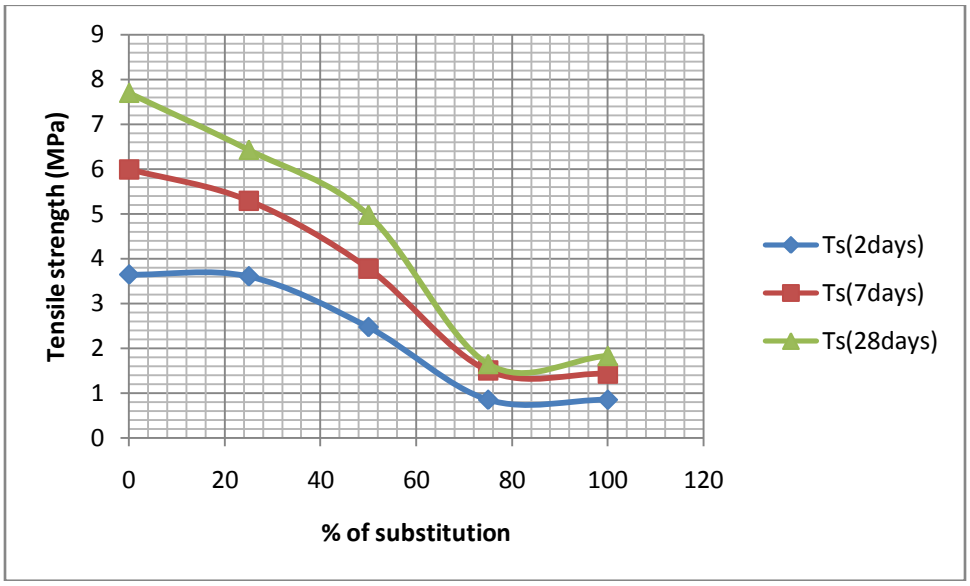

Figure 7. Change in tensile strength of the mortars according to the degree of substitution

Note that the evolution of the tensile strength in the time curves have the same shape regardless of the typeb of mortar. The tensile strength is inversely proportional to the degree of substitution of waste sand bricks.

IV.Conclusions

This research falls within the scope of the recovery of waste and by-products of the construction/demolition.In this context, it is easy to foresee both the economic and ecological interest that could have the use of recycled materials (concrete of demolition, waste brick). Thus, our literature search allowed us to identify as among the most influential parameters on the properties either fresh or cured concrete, we find the characteristics of the aggregate and the cement. In this work, we presented the results and interpretations of two experimental programs for concretes and mortars. In recent years several studies have demonstrated the viability of recycling old concrete pavement from buildings or other structures as a source of aggregates. This practice saves materials and energy. Itconsistsof:

- Remove the old concrete
- The grinding in primary and secondary crushers,
- The rid of the reinforcing steel and embedded items,
- Sifting and wash the pieces,
- Store the coarse aggregate and fine aggregate.

We must prevent dirt, plasterboard, wood and other foreign substances contaminate the final product. Recycled concrete is simply the old crushed to produce concrete aggregates. He gave good results, it can be used in the foundation layers as in lean concrete, in soil-cement and as the only source of aggregate or partial replacement of the aggregate in new concrete. Recycled concrete aggregates are generally more absorbent and less dense than ordinary aggregates. Particle shape is similar to that of the crushed stone. It is important to determine the sulfate content of recycled concrete to assess the risk of reactivity with these destructive substances. It is also the case in determining the content of soluble chlorides in the water. The concrete made with aggregates from recycling, generally has good handling qualities, durability and resistance to the action of freeze-thaw. The compressive strength varies with the strength of the original concrete and water / binder ratio of new concrete. Can be increased with a higher content of binder and replacing a portion of the recycled aggregate concrete ordinary. New concrete will also be a lower density. As with any new source of aggregate, be sure to check the durability, size and other properties of recycled aggregates. Variability properties of old concrete, which influences the new ones, is a major problem in concrete recycling. Can partly be avoided by frequently checking the properties of old concrete being recycled, it may be necessary to adjust dosages. As for the study of mortars: Sands based waste bricks are generally less absorbent and denser than ordinary sand. The mortar made with sand from waste brick, generally has medium quality Haut du formulaire The compressive strength varies with the strength of the original concrete and water / cement ratio of new concrete, It can be increased with a higher content of binder and replacing a portion of the recycled aggregate by ordinary aggregates. New concrete will also be a lower

density. As with any new source of aggregate, it be sure to check the durability, size and other properties of recycled aggregates. Variability properties of old concrete, which influences the new ones, is a major problem in concrete recycling. Can partly be avoided by frequently checking the properties of old concrete being recycled, it may be necessary to adjustdosages. As for the study of mortars: Sands based waste bricks are generally less absorbent and denser than ordinary sand. The mortar made with sand from waste brick, generally has medium quality of handling, the strengths vary depending to the rate of substitution of waste sand bricks.

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