ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 12, Issue, 01, pp. 53519-53525, January, 2022
https://doi.org/10.37118/ijdr.23753.01.2022

RESEARCH ARTICLE OPEN ACCESS

CONTAINERS SIZING TO STORAGE CONSTRUCTION AND DEMOLITION (C&D) WASTE IN BUILDINGS METHOD PROPOSAL

Julia M. C. Vendramim*, Rodrigo E. Córdoba, Luiz Paulo da Silva and José C. Marques Neto

Universidade Federal of São Carlos, Highway Washington Luiz, s/n - São Carlos/SP, Brazil

ARTICLE INFO

Article History:
Received 01st October, 2021
Received in revised form
20th November, 2021
Accepted 29th December, 2021
Published online 30th January, 2022

Key Words:
Environment, Civil Construction Waste Containers, Container Sizing, Construction site design, Construction waste management, C&D debris.

Corresponding author:
Julia M. C. Vendramim

ABSTRACT

The main objective of this work is to present a method proposal for containers sizing aimed to the storage and transport of C&D wastes at construction sites. For this, a survey of the main containers used for storage of different types of waste was carried out and the sizing of the containers was performed through a case study that was applied to residential buildings. Results of the generation estimate per pavement identified the predominance of 24.49 m³ (0.078m³/m²) of mortar, concrete and ceramic waste (class A) at the structure and sealing phases. It was also observed the predominance of these residues in the finishing and coating phases, in which the waste indicated 41.10 m³ (0.132m³/m²) per pavement. By applying the proposed method, it was observed the relationship between quantity parameters generated with the capacity of containers, removal frequency and duration of macro steps, in which it was possible to observe the necessity to balance storage capacities and removal frequency for predominant generation waste. It's concluded that the application of the method can help in the initial sizing of construction sites projects, but this method may still depend on refinement regarding other variables and specific behavioral conditions of the construction site.

Citation: ***Julia M. C. Vendramim, Rodrigo E. Córdoba, Luiz Paulo da Silva and José C. Marques Neto.*** "Containers sizing to storage construction and demolition (c&d) waste in buildings method proposal*", International Journal of Development Research*, 12, (01), 53519-53525.

INTRODUCTION

The wastage of materials, the incorrect separation of waste at construction sites, the absence of reusing and recycling procedures and the difficulties in preparing projects for the management of these waste at construction sites contribute to increase the generation of construction and demolition waste (C&D) in Brazil. The large amount of waste generated may lead to problems in the organization of the sites and work safety, promote the proliferation of disease vectors, which can cause accidents, health problems for the population, or environmental impacts, such as the reduction of the landfills lifespan.

In this context, the necessity to develop civil construction waste management methods that are capable of reducing, reusing or recycling waste is noticeable. Besides it meets environmental issues, this management is straight linked to economic issues of construction companies, that often do not have idea of the volume and types of waste generated at the construction sites, when the entire society is benefited from the sustainable use of raw materials from civil construction and the correct disposal of their waste (VIEIRA et al., 2019). In Brazil, the rates of generation at buildings can vary from 0.0519 to 0.125 m³/m² tax converted based on C&D waste 1,200 kg/m³ unit mass (PINTO, 1999; COSTA, 2012). In Spain, these generation rates in residential areas range from 0.0746 to 0.308 m³/m² (MAÑÀ I REIXACH *et al.,* 2000; LLATAS, 2011; VILLPRIA SAÉZ; DEL RÍO MERINO; PORRAS-AMORES, 2011). It emphasizes a hierarchy to be followed in C&D waste management, in which the non-generation of waste must be prioritized, and if this is not possible, the focus must be on, respectively, reducing the amount of waste generated, the reuse of waste, recycling, and, as a last resort, the correct treatment and final disposal of waste (ALI*et al.,* 2019; BRASIL, 2002; BRASIL, 2010). The study by Gálvez-Martos*et al.* (2018) presents a synthesis of the best practices in C&D waste management in Europe. Among them, the authors mention techniques of collecting and separating waste at construction sites, such as to identify the packaging containers for each type of waste, to size correctly each container considering the waste amount that will be generated, the number of containers and the number of foreseen waste removals, the location of fixed containers in a waste yard and

temporary ones near the work fronts to increase the efficiency of separation, to apply training to all workers and to map the location of the containers at the construction site and to make this mapping available to all employees involved. In study performed by SAEZ *et al.* (2013) was applied a questionnaire to construction companies on the best practices in waste management, and it was identified that 43% of these companies carried out local waste separation and 57% carried out planning regarding the number and the size of containers required for each activity. The authors identified that the distribution of small containers was considered the third measure of the 13 best practices analyzed at the construction site, although only 36% of the respondents implemented this measure in their activities.

- Place of use of the container (internal or external to the construction site);
- Construction stage of use of the container;
- Type of construction that uses the container;
- Space required on the construction site for the container;
- Container emptying frequency;
- Type of internal or external transport of the container;

Estimate of generation of C&D wastes: For the sizing of the containers, it is necessary to estimate the generation of C&D wastes. For this, it is necessary to adopt generation indicators, which can come from the literature, based on works of similar construction

Table 1. C&D wastes indicators per macro step of construction

Phases of the Construction	Generated RCC indicator (m³/m² built) - Construction 1	Generated RCC indicator (m³/m² built) - Construction 2	Generated RCC indicator (m³/m² built) - Construction 3	Generated RCC indicator (m³/m² built) - Construction 4	Generated RCC indicator (m³/m² built) - Construction 5	Average of indicators (m³/m² built)	Association of indicators (m³/m² built)
Structure	0,0418	0,0349	0,0396	0,0149	0,0388	0,0340	0,0902
Sealing	0,0558	0,0628	0,0792	0,0446	0,0388	0,0562	
Coatings	0,0837	0,0488	0,1188	0,0446	0,0388	0,0670	0,1366
Finishing	0,0697	0,0419	0,1188	0,0595	0,0582	0,0696	

Source: Authors (2021), based on data survey Marques Neto (2003)

In Brazil, CONAMA Resolution No. 307 (BRASIL, 2002) and the National Solid Waste Policy – PNRS (BRASIL, 2010) determine that the biggest waste producers elaborate a Construction Waste Management Plan, in which they are responsible for their waste packaging and proper final disposal. In order to prepare this plan correctly, it is necessary that the generator be aware of the types and volumes of waste produced, the possibilities of C&D waste management actions at the construction site and the peculiarities of the enterprise, what implies the need to develop specification, quantification and management methods. In this context, the main objective of this paper is to present a method proposal for sizing containers regarding the storage and the transport of C&D wastes at residential building construction sites. The specific objectives to be achieved are: to analyze practical actions to store wastes on pavements; to estimate the generation of waste; and to evaluate the sizing and distribution of the containers on the pavements.

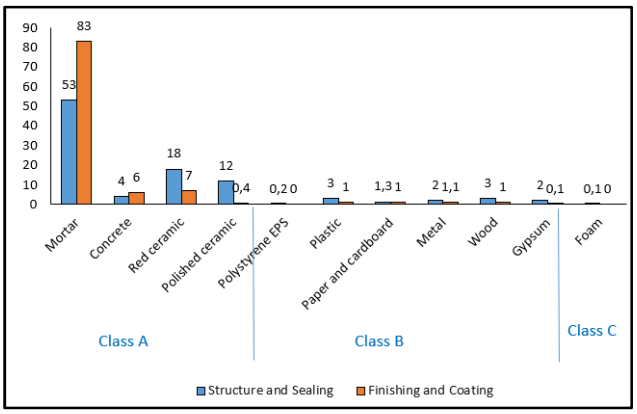
MATERIALS AND METHODS

The method proposal of sizing of C&D wastes storage containers was developed from a case study in a multi-storey residential building project. The studied building has the following characteristics: reinforced concrete structure, block sealing, mortar and ceramic coating, and there are seven identical reference pavements with an area of 312.10 m² each. There are two apartments at the reference pavement with an area of 126.50 m² each, providing a total of fourteen (14) apartments. Thus, this study was based only on the sizing for the application of containers at the pavements, that is, the organization of waste in the first generation front. The proposed sizing method was carried out in three stages: survey of containers, the estimate of waste generation, and sizing of containers that allocation is at the pavement. These steps are described below:

Survey of practices for adopting containers: In order to evaluate the practical actions of C&D WASTES management at the construction site, first bibliographic research was carried out on this theme in the literature, for the purpose of concatenating information about the different containers and transports used in construction sites in Brazil. As a result, a comparative table of the studied practical actions of C&D wastes management was obtained, encompassing the information found regarding the analyzed aspects. The main aspects observed were:

- Classes of C&D wastes suitable for the container;
- Types of C&D wastes suitable for the container;
- Volumetric capacity of the container;

systems, size and location, or they can be obtained from the experience of the construction company itself, based on previous works. In order to build generation indicators, bibliographic data was initially collected on the volume of waste removed from Brazilian constructions studied by Marques Neto (2003). It was possible to construct, from these data and from the areas of the construction sites, an average estimative indicators of C&D wastes generation per macro step in m³/m², as shown in Table 1.



Source: Gouveia *et al.* (2017), adapted by the authors

Figure 1. Average percentage composition of C&D per construction macro step

Thus, the calculation of volumes of C&D wastes generated per macro step of construction sites can be done using Equation 1, which was developed in this study

$$VT = I \times A \quad (1)$$

Considering the following: VT: Total volume of C&D wastes generated in a given macro step [m³]

I: Indicator of C&D wastes generation per macro step or association of macro steps [m³/m²]

A: Total area of the building to be built [m²]

The generation of each type of waste was obtained using gravimetric composition data from residential constructions. Therefore, in this study, it was used data on the percentage composition of C&D wastes obtained by Gouveia *et al.* (2017), which is presented in Figure 1. Thus, the calculation of the volumes of each type of C&D wastes generated per macro step of construction can be done using Equation 2.

Table 2. Summary of packaging devices and transport suitable for each type of C&D wastes at pavements

Waste	Volume capacity	Class Resolution CONAMA No. 307	Initial packaging	Internal transport	Final packaging	External transport
Blocks, mortar, concrete and ceramics	Up to 0.5m³	A [1]	20L, 50L or 200L drums	Wheelbarrow	Construction dumpster or piles	Multi-crane truck or tipper truck
	Above 0.5m³ to 1.5m³	A	Piles	Wheelbarrow and rack elevator, or crane or conductive pipe	Construction dumpster or piles	Multi-crane truck or tipper truck
Wood	Up to 0.5m³	B [2]	50L or 200L drums, Pallet box	Manual transport with raffia bag or wheelbarrow or construction trolley Elevator Transpallet	Roll on/roll off boxes or dumpster or stalls	Multi-crane truck
	Above 0.5m³ up to 2.0m³	B	Stalls	Elevator	Roll on/roll off boxes or stationary dumpster or stall	Multi-crane truck
Metal	Up to 0.5m³	B	50L or 200L drums Pallet box or bag	Wheelbarrow or Construction trolley Transpallet	Roll on/roll off boxes or dumpster or stalls	Wooden body truck
	Above 0.5 m³ up to 2.0 m³	B	Stalls	Elevator or crane	Roll on/roll off box	Multi-crane truck
Gypsum and gypsum board	Up to 0.5m³	B	50L or 200L drums	Manual transport with raffia bag or wheelbarrow or construction trolley Elevator	Roll on/roll off boxes or stationary dumpster or stalls or piles	Multi-crane truck or tipper truck
	Above 0.5m³ to 1.5m³		Piles	Wheelbarrow or Construction trolley Elevator	Roll on/roll off boxes or stationary dumpster or stalls or piles	Multi-crane truck or tipper truck
Paper, Cardboard and Plastic	-	B	Big Bag or 50L or 200L drums	Wheelbarrow or construction trolley or elevator	Big Bag or Shelter or Cage	Wooden body truck
EPS	-	B	Raffia Bag or Big Bag	Manual transport	Cage or stall	Wooden body truck
Sawdust	-	B	50L drums or raffia bag	Elevator	Stall	Wooden body truck
Glass	-	B	50L drums	Manual transport with raffia bag or wheelbarrow or construction trolley	Stall	Wooden body truck
Foams, tapes, residues	-	C [3]	50L, 200L drums or Big Bag	Manual transport with raffia bag or wheelbarrow or construction trolley	Stall	Wooden body truck
Hazardous waste	-	D [4]	Pallet or 50L, 200L drums	Manual transport or transpallet	Stall or shelter	Trunk truck or tank car

[1] Class A - reusable or recyclable waste as aggregates, such as ceramic components (bricks, blocks), grout and concrete;
[2] Class B - recyclable waste for other destinations, such as plastics, metals, wood and gypsum;
[3] Class C - waste without economically viable technologies or applications for recycling or recovery;
[4] Class D - hazardous waste, such as paints, oils and asbestos.

$$VR = P \times VT \quad (2)$$

Considering the following:

VR: Volume of a given type of C&D wastes generated in a given macro step [m³]
P: Percentage found of this type of C&D wastes within the total volume of waste of a given macro step [%]
VT: total volume of C&D wastes generated in a given macro step (see equation 1) [m³]

Finally, in order to determine the volume on each work front, it is necessary to be aware of the volume of each type of C&D WASTES generated per pavement. Therefore, this calculation can be done following Equation 3:

$$VP = VR/NP \quad (3)$$

Considering the following:
VP: Volume generated per pavement of a given type of C&D wastes in a given macro step [m³]
NP: Number of pavements of the building to be built
VR: Volume of a given type of C&D wastes generated in a given macro step (value calculated in the previous equation) [m³]

Sizing and proposal for distribution of containers: To calculate the frequency of emptying the container and correlation of variables, it was used Equation 4, developed by Vendramim*et al.* (2021). It is noteworthy that, for better site logistics, the number of containers equal to 1 was initially considered and this number was increased according to the calculated emptying frequency.

$$FE = \frac{VP}{R \times CV \times D} \quad (4)$$

Considering the following:
FE: Frequency of emptying per week
VP: Total volume of C&D wastes generated in the macro step [m³]
C: number of containers
VC: volumetric capacity of the container [m³]
D: duration of macro step [weeks]

Regarding the calculated generation volumes of each type of C&D WASTES and the possibilities of practical actions of C&D WASTES presented, proposals were prepared for packaging and transporting of C&D WASTES for each macro step of the construction. Thus, the calculated volumes were used for the choice, sizing and positioning at the pavement of the C&D wastes packaging containers at the work front. It should be notified that in this paper the structure and sealing macro steps were estimated throughout 6 months and finishing and coating 18 months.

2 lists the total values generated by a set of macro steps and volumes generated per pavement according to the waste type. Results of the generation estimate per pavement identified the predominance of 24.49 m³ (0.078m³/m²) of mortar, concrete and ceramic waste (class A) at the structure and sealing phases. It was also observed the predominance of these residues in the finishing and coating phases, in which the waste indicated 41.10 m³ (0.132 m³/m²) per pavement. This predominance reflects the characteristics of the reinforced concrete construction, sealing in ceramic blocks and mortar and ceramic coating. It's observed with these data that there is a discrepancy in the generation of class B waste compared to class A waste, represented by the generation of 3.24 m³ (0.010 m³/m²) of pavement in the structures and sealing phases, and 1.79 m³ (0.006m³/m²).

Sizing and proposal for distribution of containers : Considering the calculated generation volumes of each type of C&D wastes and the durations of each macro step of the construction, proposals for packaging and transporting waste were elaborated for each macro step of the construction.

Table 3. Generated volume of C&D WATES total and per pavement

Class Resolution CONAMA No. 307	Waste Type	Structure and sealing			Finishing and coating		
		Generated volume (m³)	Generated Volume per pavement (m³)	Indicator per class and pavement (m³/m²)	Generated volume (m³)	Generated Volume per pavement (m³)	Indicator per class and pavement (m³/m²)
A	Mortars	104,44	14,92	0,078	247,70	35,39	0,132
	Concrete	7,88	1,13		17,91	2,56	
	Red ceramic	35,47	5,07		20,89	2,98	
	Polished ceramics	23,65	3,38		1,19	0,17	
B	Polystyrene (EPS)	0,39	0,06	0,010	-	-	0,006
	Plastic	5,91	0,84		2,98	0,43	
	Paper and cardboard	2,56	0,37		2,98	0,43	
	Metal	3,94	0,56		3,28	0,47	
	Wood	5,91	0,84		2,98	0,43	
	Gypsum	3,94	0,56		0,30	0,04	
C	Foam	0,20	0,03	0,001	-	-	-

Table 4. Solutions adopted for packaging devices and transport of C&D wastes in the structure and sealing, and finishing and coating phases

Waste	Structure and sealing		Finishing and coating	
	Packing at the pavement	Internal transport	Packing at the pavement	Internal transport
Mortars	Piles	Duct	Piles	Duct
Concrete	Piles	Duct	Piles	Duct
Red ceramic	Piles	Duct	Piles	Duct
Polished ceramics	Piles	Duct	Piles	Duct
Polystyrene (EPS)	*Bag* for Class B	Elevator rack	*Bag* for Class B	Elevator rack
Plastic	*Bag* for Class B	Elevator rack	*Bag* for Class B	Elevator rack
Paper and cardboard	*Bag* for Class B	Elevator rack	*Bag* to Metal	Elevator rack
Metal	*Bag* to Metal	Elevator rack	Drum for Wood	Elevator rack
Wood	Drum for Wood	Elevator rack	Drum for gypsum	Elevator rack
Gypsum	Drum for gypsum	Elevator rack	Piles	Duct
Foam	Drum for Class C	Elevator rack	Piles	Duct

RESULTS

Types of C&D wastes packaging containers: Based on the bibliographic review carried out on C&D wastes packaging containers and C&D WASTES transporting equipment on construction sites, it was possible to build a summary table (Table 1) containing a list of the types of waste and the main containers, characteristics, and their types of transport.

Estimate of generation of C&D wastes: From the procedures and formulations described in this study, it was possible to estimate the volume of each type of wastes generated per pavement and per macro step of the construction. However, it was opted for the compatibility and association of the studied macro steps by Gouveia *et al.* (2017) and Marques Neto (2003), due to the lack of detailed studies on the characterization of C&D WASTES per macro step of the construction and due to the objective of this paper to serve as a basis for the method proposal of containers sizing for management purposes. Table

By setting guidelines, it was decided to use the devices chosen for a certain type of waste throughout the construction period in all macro steps, with the aim of preventing workers from confusing the containers due the exchange during the construction performance. It was also sought to group in the same device the materials that can be packed and disposed of together, as is the case of Class B waste, Class A gray type (concrete and mortar) and Class A red type (ceramics and ceramic blocks), in order to facilitate separation and to reduce the number of containers used, thus, facilitating the management of these devices at the construction site and reducing the space occupied by them. During the structure and sealing, and finishing and coating phases, waste is generated on each pavement as the construction is performed. In this way, each type of generated waste is initially treated in terms of packaging inside the pavement and in terms of transporting this waste from the pavement to the waste yard. The solutions adopted for the situations described above for packaging and transporting these wastes are presented in Table 2 and 3. In both macro steps, Class B wastes were separated into 4 groups: metal, wood, gypsum and other Class B waste (plastic, paper,

Table 5. Proposal for packaging devices and transport of C&D WASTES from the structure and sealing phase - per pavement

Waste	Generated volume (m³)	Device used	Device volumetric capacity (m³)	Number of needed devices	Duration of macro step per pavement	Calculated average emptying frequency	Practical average emptying frequency
Class A	24,49	Stack	1,00	4	18 days	2.0 times a week	2 times a week
Class B except wood, plaster and metal	1,27	*Bag* for Class B	1,00	1	18 days	1.7 times per month	2 to 3 times a month
Gypsum	0,56	Drum for gypsum	0,05	2	18 days	1.9 times a week	2 times a week
Metal	0,56	*Bag* to Metal	1,00	1	18 days	0.7 time per month	1 time per month
Wood	0,84	Drum for Wood	0,20	1	18 days	1.4 time a week	2 times a week
Foam	0,03	Drum for Class C	0,05	1	18 days	0.8 time per month	1 time per month

Table 6. Proposal for packaging devices and transport of C&D WASTES from the finishing and coating phases - per pavement

Waste	Generated volume (m³)	Device used	Device volumetric capacity (m³)	Number of needed devices	Duration of macro step per pavement	Calculated average emptying frequency	Practical average emptying frequency
Class A	41,10	-	-	-	54 days	constant	constant
Class B except wood and metal	0,85	*Bag* for Class B	1,00	1	54 days	0.4 time per month	1 time per month
Gypsum	0,04	Drum for gypsum	0,05	1	54 days	0.4 time per month	1 time per month
Metal	0,47	*Bag* to Metal	1,00	1	54 days	0.2 time per month	1 time
Wood	0,43	Drum for Wood	0,20	1	54 days	1.0 time per month	1 time per month

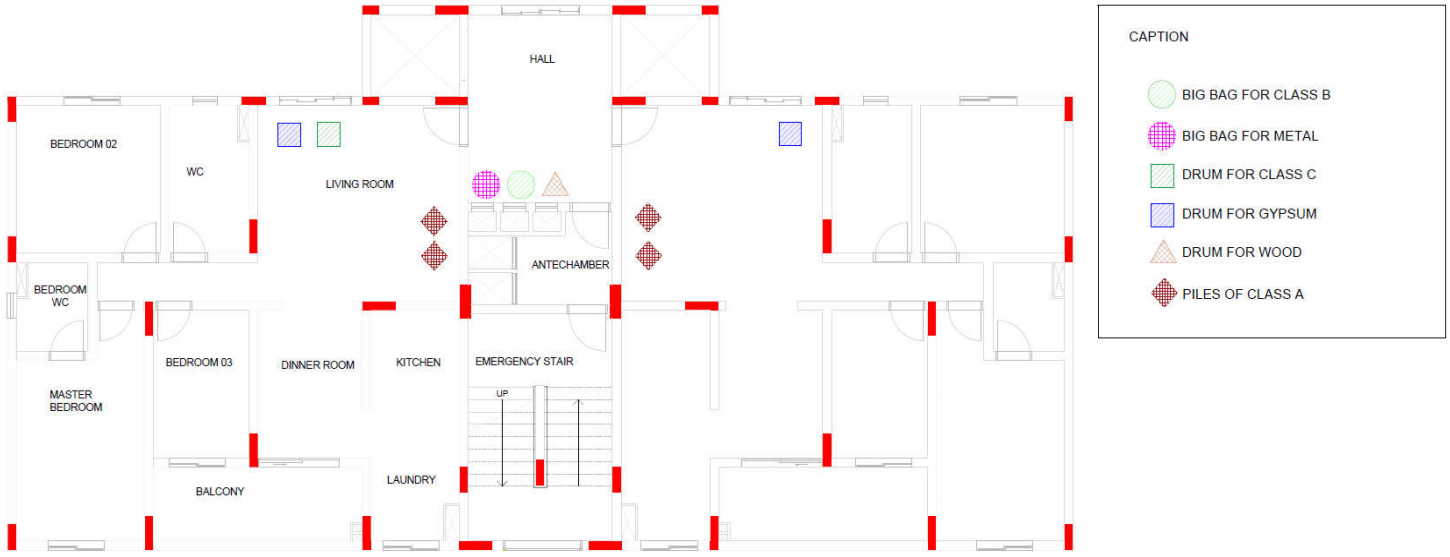


Figure 2. Location of C&D WASTES devices packaging and transport in the stage of structure and sealing to the reference pavement

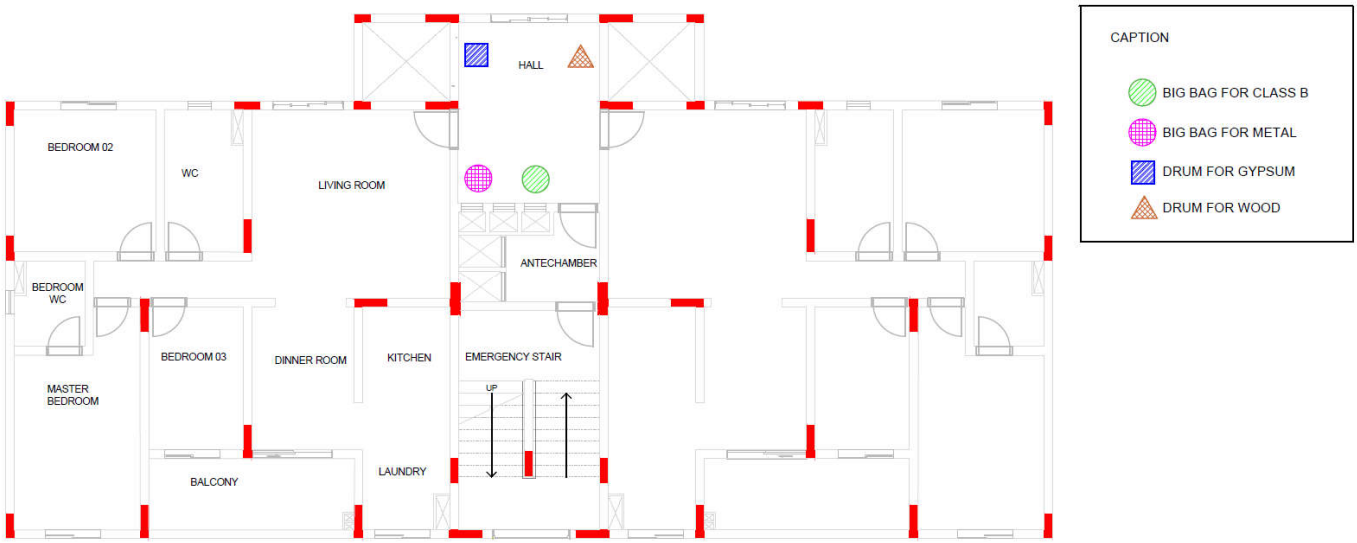


Figure 3. To place the packaging devices and transport of C&D WASTES in the finishing and coating stage in the reference pavement

cardboard and EPS). Another aspect to be highlighted in the solutions proposed for these phases of the construction is the choice of waste ducts for conducting Class A waste, as it is a very efficient and simple manner of conduction, and it allows other options of vertical transport, such as the rack elevator, to prioritize the wastes that cannot be transported in this way inside the construction, which facilitates the cleaning and logistics of this equipment. After defining the adopted solutions, the pre-sizing of the devices was done using Equation 4. Thus, the number of containers used and their frequency of emptying in each macro step were determined, as shown in Tables 3 and 4. After sizing the devices, it was possible to propose their location per pavement in the two macro steps considered. In the structure and sealing stage, the guideline adopted was to prioritize that Class A waste piles, as they are heavier and voluminous, be temporarily allocated within the reference apartment in order to be close to the transport duct and to not interfere in internal traffic at the hall of the pavement. Another consideration was to allocate a gypsum drum in each reference apartment, to facilitate the transport of this waste, which is generated in a significant amount. The other containers were allocated in the hall on the pavement, except the Class C Wastes drum, which was placed in one of the apartments, so it does not make the movement in the hall difficult and allows the people passage on the stairs. The location of these devices is shown in Figure 2. In the finishing and coating stage, all devices were placed in the pavement hall to facilitate their removal using the rack elevator. In the project, it was decided not to pack Class A wastes, and their cleaning is carried out through ducts on a constant basis. The location of these devices can be found in Figure 3.

DISCUSSION

Based on data from the survey of practical actions, it was possible to observe different options for storaging containers in front works (pavement). The options for using small "separation containers" proved to be viable in terms of storage time, container distribution and emptying frequency, except for the storage of class A waste, - maximum twice a week for Class A, gypsum and wood in the structure and sealing phase. Regarding the generation estimate, the predominance of class A waste generation can be observed, representing 24.49 m³ (0.078m³/m²) in the structure and sealing phases, and 41.10 m³ (0.132 m³/m²) in the finishing phases. The sum of the indicators for the macro steps associations presents a value of 0.210m³/m², which according to the literature, it is contained within the estimated generation range for new constructions in the study by Del Río Merino and Porras-Amores (2011). By applying the proposed method, the relation between parameters of quantity generated and the capacity of containers, removal frequency and duration of macro steps was observed, in which it was possible to notice that the proposed formulations facilitate the search for a balance of storage capacities and frequency of removal, mainly for residues of predominant generation. It is concluded that the application of the method can help in the initial sizing of construction sites, but this method is still limited and needs further knowledge of other variables, such as quality of materials, behavioral factors of labor, and practices applied by builders in the control and registration of amounts of waste generated through the activities. All these factors can be controlled by the construction company, that is, the generation of waste can be modeled and optimized by those responsible to a certain extent. The method for initial sizing of C&D wastes packaging containers presented can be very useful for the preparation of the waste management project during construction. By following the steps described, it is possible to reach satisfactory results in the generation of waste and, in this way, to perform a good planning of practical actions in the construction site for the management of these wastes. An important observed consideration is that it is necessary to pay attention to the particularities of each analyzed construction for a planning that is more in accordance with reality, since there are several factors that influence the generation of C&D wastes. The ideal scenario is that each construction company determines its own indicators for the estimate of waste generation and carry out periodic verifications on the sizing efficiency, in order to adapt the initial sizing regarding the control and behavioral variables.

ACKNOWLEDGMENTS

I would like to thank the Department of Civil Engineering at the Universidade Federal of São Carlos for the support and infrastructure in the development of this paper, and to the Postgraduate Program in Civil Engineering at the Universidade Federal of São Carlos for the support received.

REFERENCES

Ali, T. H., Akhund, M. A., Memon, N. A., Memon, A. H., Imad, H. U. and Kharo, S. H. 2019. Application of Artifical Intelligence in Construction Waste Management. Proceedings of 2019 8th *International Conference on Industrial Technology and Management,* pp. 50–55.

Brazil. 2002. Resolution nº 307 - C&D waste management Brasília: Conselho Nacional do Meio Ambiente.

Brazil. (2010) Law No. 12.305, de 2 de Agosto de 2010. National Policy of Solid Wastes. DiárioOficial da União, Brasília.

Costa, R. V. G. (2012) Taxa de geração de resíduos da construção civil em edificações na cidade de João Pessoa. Dissetation (Mastering in Engenharia Urbana e Ambiental) - Centro de Tecnologia. Universidade Federal da Paraíba, João Pessoa, Brasil.

Gálvez-Martos, J. L., Styles, D.; Schoenberger, H. and Zeschmar-Lahl, B. (2018) Construction and demolition waste best management practice in Europe. Resources, Conservation and Recycling, v. 136, pp. 166–178.

Gouveia, T. A, Picanço, A. P., Serra, J. C. V. andPortelinha, T. C. G. (2017) Composição gavimétrica do resíduo produzido na construção de edificações residenciais multifamiliar em Palmas (TO). Congresso ABES FENASAN 2017. Disponível em: <http://abes.locaweb.com.br/XP/XP-EasyArtigos/Site/Uploads/Evento36/TrabalhosCompletosPDF/III-113.pdf>.

Llatas, C. (2011) A model for quantifying construction waste in projects according to the European waste list. Waste Management, v. 31, no. 6, p. 1261-1276. https://doi.org/10.1016/j.wasman.2011.01.023.

Mañà, I., Reixach, F., Sagrera, I., Cuscó, A., González, I. and Barroso, JM (2000) Base de dados BEDEC Availableat: <Availableat: http://www.itec. es/nouBedec.e/bedec.aspx >.

Pinto, T. P. (1999) Differentiated methodology for solid waste management of urban construction Thesis (Doctoral) - Polytechnic School, University of São Paulo, São Paulo, Brazil.

Vendramim, J. M. C. (2021) Projeto de manejo de resíduos da construção civil como subsídio para elaboração de planos de gerenciamento: estudo de caso em edificação de múltiplos pavimentos. Trabalho de Conclusão de Curso. Universidade Federal de São Carlos, São Carlos, Brazil.

Vendramim, J. M. C., Marques Neto, J. C., Silva, L. and Córdoba, R. E. (2021) Método de pré-dimensionamento de recipientes de armazenamento de resíduos da construção civil. In: SIMPÓSIO BRASILEIRO DE GESTÃO E ECONOMIA DA CONSTRUÇÃO, XII., 2021, Maceió, Alagoas. Anais... Porto Alegre: ANTAC.

Villoria-Sáez, P., Del Río Merino, M. and Porras-Amores, C. (2011) Estimation of construction and demolition waste volume generation in new residential buildings in Spain. Waste Management & Research, v. 30, n. 2, p. 137-146. https://doi.org/10.1177/0734242X11423955.

VilloriaSaez, P., Del Río Merino, M., González, A. S. and Porras-Amores, C. (2013) Best practice measures assessment for construction and demolition waste management in building constructions, Resources, Conservation and Recycling, Volume 75, 2013, pp 52-62, ISSN 0921-3449, https:/ /doi.org/10.1016/ j.resconrec.2013.03.009.

****