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Pet y vidrio molido como agregado reciclado en la mezcla de pavimentos

**TRABAJO DE INVESTIGACIÓN PARA OPTAR EL GRADO ACADÉMICO DE
BACHILLER EN INGENIERÍA CIVIL AMBIENTAL**

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Índice

Resumen	4
Abstract	5
Introducción	6
Referencias	15

Resumen

El siguiente artículo titulado “Pet y vidrio molido como agregado reciclado en la mezcla de pavimentos en el distrito de José Leonardo Ortíz.” trata sobre el uso de PET y vidrio molido, que van hacer posible la elaboración pavimento asfálticos y rígidos, además de los diferentes resultados obtenidos en ensayos de compresión de las diversas investigaciones realizadas. Como bien sabemos, existen diversos resultados para la elaboración de un pavimento por eso que se realizó el criterio de exclusión que permitirá que no se estudien residuos orgánicos, los cuales al evaluarlos no cumplan con los requisitos mínimos de las normativas, como es el caso del papel, hojas, cascaras, cartón entre otros materiales. Por el contrario, como criterios de inclusión tenemos el PET y vidrio molido. Para realizar este artículo, se ha provisto de una revisión de artículos y análisis de los ensayos que fueron sometidas a ensayos de compresión para que cumplan con los parámetros mínimos que están establecidos en la NTP. Para el concreto se elaborarán 24 probetas, que tendrán adiciones pulverizadas de vidrio y PET, teniendo en cuenta su granulometría. Las técnicas que serán utilizadas para recopilar los datos y resultados serán la observación en campo y los ensayos realizados en el laboratorio y el tipo de investigación es descriptivo y correlacional. Una vez que se ha identificado los criterios de inclusión y exclusión se ha realizado una comparación de un análisis y además de todos los resultados obtenidos.

Palabras clave: Pet, vidrio Molido, Pavimentos Asfálticos, Pavimentos Rígidos.

Abstract

The following article entitled "Pet and ground glass as recycled aggregate in the mixture of pavements in the district of José Leonardo Ortíz" deals with the use of PET and ground glass, which will make possible the elaboration of asphalt and rigid pavements, in addition to the different results obtained in compression tests of the various investigations carried out. As we know, there are different results for the elaboration of a pavement, that is why the exclusion criterion was made to avoid the study of organic waste, which when evaluated does not meet the minimum requirements of the regulations, as is the case of paper, leaves, shells, cardboard, among other materials. On the contrary, as inclusion criteria we have PET and ground glass. For the realization of this project, samples will be taken and then subjected to compression tests to comply with the minimum parameters established in the NTP. 24 specimens will be prepared for the concrete, which will have pulverized glass and PET additions, taking into account their granulometry. The techniques that will be used to collect data and results will be field observation and laboratory tests, and the type of research is descriptive and correlational. Once the inclusion and exclusion criteria have been identified, a comparison has been made of an analysis and also of all the results obtained.

Keywords: Pet, Ground Glass, Asphalt Pavements, Rigid Pavements.

Introducción

Today, the different countries of the world produce more solid waste and less recycling, many of the materials that have been discarded and take a long time to decompose can still be reused and not become garbage. In Peru, construction is one of the main drivers of national growth, contributing 6% of GDP (2019) and boosting more than 8 sub-sectors of the economy thanks to its multiplier effect.. (cemex, 2020) Also, in Peru, around 23 thousand tons of garbage are produced every day. (el Peruano, n.d.), which are not entirely taken to dumps or managed in a correct way; as well as the collection system is deficient, causing its accumulation in the various public roads. At present there is a large accumulation of inorganic waste, some of the materials we have glass and PET (polyethylene terephthalate) plastic, which due to their physical properties can be reused in many ways, such as for use in the manufacture of building materials such as concrete and brick. Most of these wastes pollute the environment surrounding the cities, destroy different ecosystems of life, water sources and contaminate soils.

The same problematic situation of large accumulations of garbage is also present in the district of José Leonardo Ortiz, in the province of Chiclayo, Lambayeque region, which, due to various causes such as the lack of basic services, poor waste collection by the municipality and the lack of environmental awareness of its inhabitants, has led to the accumulation of about 20 tons of garbage daily.(PERÚ, n.d.) In view of this environmental problem, the review article aims to demonstrate that construction and demolition wastes can be used, since they can be reused to implement and/or improve properties, as in this case, self-compacting asphalt pavement, becoming one of the many forms of recycling, compiling the different research on the behavior of construction materials based on recycling. Besides providing an improvement to the environment, it contributes to the economy of consumers, since materials made with PET and glass turn out to be cheaper than conventional ones. Feasibility of constructing pavements with PET and ground glass.

The reuse of solid materials would not only provide an improvement to the environment, but also in the economic and social field, since construction materials would be elaborated within the reach of the most vulnerable and low-income people, providing a significant source of work and organization. It is also feasible because it reduces the high concentration of solid waste, making use of it in the construction industry and preventing it from being discarded and contaminating coastal ecosystems.

The reuse of recycled materials, in addition to providing environmental solutions, also has an economic impact, such as reducing the cost of construction materials, so that they are affordable for the district of José Leonardo Ortiz..

Systematic literature reviews and systematic mapping studies.

Keywords: Construction materials reuse, construction glass recycling, construction materials, construction materials solid waste and ISSN, PET construction recycling, civil engineering recycling, Civil Engineering Repository.

Data base: As database to extract the articles were the following: Redalyc Org, Scielo, Google Scholar, Proquest.

Search Process : As a search process, the keywords mentioned above were used and placed between quotation marks, another search process was to place the filetype command, which was placed after the content between quotation marks, the AND connector, ISSN and aca-demic publications were also used; thus obtaining an initial total of approximately 110 articles found, but at the time of making the individual analysis of the articles, the same web page reduced to a final total of only 15 articles, specifying duplicity in some of the 110 articles initially shown. Finally, the articles were sorted by language.

Web	Término de Búsqueda	Total
Scielo	"Reutilización de vidrio molido AND ISSN"	4
ProQuest	"Resistencia a la compresión con PET AND ISSN"	3
Google Académico	"Uso de materiales reciclados AND ISSN"	5
Redalyc	"Reutilización de materiales reciclados AND ISSN"	3

Source: Own elaboration

Authors	Article Name Source	Methodological design	Year	Breve Resumen
Xargay, Hernán; Ripani, Marianela; Caggiano, Antonio; Folino, Paula; Martinelli, Enzo	Use of recycled materials in cementitious composites: Tecnura, Bogotá Vol. N° 23	Experimental	2019	It describes the use of recycled coarse aggregate, which was tested and finally came to the conclusion that it caused a deterioration in the physical, mechanical and resistant behavior of reinforced concrete.
María Azucena González Lozano y Patricia Ponce Peña	Use of waste glass in the manufacture of clay bricks: Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias Vol.N° 1	Experimental	2012	This work experimented and proved that when 15% glass is used in the clay brick, it is possible to reach resistances suitable to be used as a construction material.
Tomas Serrano;M. Victoria Borrachero;José M. Monzó;Jordi Payá	Rice husk lightened mortars: Mix design and properties evaluation.	Experimental	2012	It describes the properties that rice husk can provide, which will depend on how it is treated, whether with an acidic or basic solution. By using a basic solution, the setting and hardening of cement is obtained, and mechanical properties of mortars and concretes lighter and non-bearing use were obtained.
Elías,Jorge Sichez,Julio Reyna,Cesar	Reuse of pet plastic, paper and sugarcane bagasse as raw material in the production of ecological concrete for the construction of low-cost housing.	Experimental	2019	The following work on determining the results of the reuse of PET plastic waste, paper and sugar cane bagasse as raw material in the elaboration of ecological concrete for the construction of low-cost housing, making use of the most efficient and economical materials.

Authors	Article Name Source	Methodological design	Year	Breve Resumen
Rosana Gaggino	New construction technology using recycled materials for housing emergencies.	Experimental	2013	These slabs are made of durable materials with good thermal insulation, so that in addition to solving an emergency, they constitute a definitive and comfortable solution to the housing problem. These materials are recycled industrial plastic waste, which replace the stone aggregates of a common concrete.
Vicente Flores Ales, Victor Jimenez Bayarri, Alex Pérez Fargallo	Influences of the incorporation of crushed glass on the properties and high temperature behavior of cement mortar.	Experimental	2018	The present work will allow you to verify the behavior of mortars whose aggregates are partially replaced by crushed domestic glass from recycled materials, starting from the characterization of products with replacement percentages of 25% and 50% with respect to a reference sample.
Gabriela Cristina Silva Amigo	Creation of a company for the recycling of construction and demolition waste.	Experimental	2016	To carry out a feasibility study to create a company dedicated to the recycling of construction and demolition waste (CDW) in Lima, Peru.
María Fernanda Serrano Guzmán, Diego Darío Pérez Ruiz, Luz Marina Torrado Gómez y Néstor Darío Hernández.	Inert waste for the production of bricks with recyclable material: a practice for the protection of the environment.	Experimental	2017	It deals with the comparison of the thermographic response of the masonry that showed the best bearing capacity in order to recommend the use of eco-bricks to improve the climatic conditions inside the houses and thus satisfy the comfort of the suppliers with these inputs.

Authors	Article Name Source	Methodologic al design	Year	Breve Resumen
Xargay, Hernán; Ripani, Marianela; Caggiano, Antonio; Folino, Paula; Martinelli, Enzo	Concrete with recycled aggregates as an urban sustainability project.	Experimental	2015	It deals with the use of recycled construction materials or debris as aggregates in concrete, which is called R. Since it was carried out in Colombia, different types of materials of different standards than the Peruvian ones were used, but what we found is that it does comply with the compression conditions, where it complies for materials of non-structural use.
Rosana Gaggino	Prefabricated bricks and slabs with recycled plastics suitable for self-builds	Experimental	2008	It deals with the use of recycled materials, such as PET plastic, for the manufacture of bricks and concrete slabs in order to promote self-construction by men and women, which were tested, complying with the regulations for masonry pieces. The article concludes with the construction of a housing module in Córdoba, Argentina.
Juan Carlos Rodriguez Romo	Bamboo as a construction material	Experimental	2006	Replace expensive construction materials with inexpensive materials that are suitable for a region of high seismicity.
Sumaya Jaimes Reategui, Edgar Grimaldo Matto Pablo, Lucio Torres Romero, Heli Santiago Romero	Housing module with recyclable material in the city of Huánuco	Experimental	2018	Construction of housing modules in the city of Huánuco, transforming solid waste into useful elements for housing construction, as well as presenting a proposed solution to the housing shortage and the problem of environmental pollution.

Authors	Article Name Source	Methodological design	Year	Breve Resumen
Mendoza Isabel; Chávez Sandra	Construction and demolition wastes as aggregate for new hydraulic concrete	Experimental	2017	It refers to the use of crushed aggregates from civil works, it has been used to generate recycled hydraulic concrete, a material that can lower costs and reduce construction costs, in addition to reducing pollution because it represents multiple environmental advantages, since the waste will not reach basins or open dumps for final disposal, also avoiding the consumption of nonrenewable natural resources renewable natural resources

Research questions

In this study, 2 research questions were asked.

1. Is it possible to add Pet waste to concrete and still meet the minimum requirements of the NTP?
2. Is it possible to add ground glass to concrete that meets the minimum requirements of the NTP??

Population, study sample and sampling.

For Concrete.

The population is 24 cylindrical specimens for each concrete mix design with PET plastic and glass.

The sample consists of 24 cylindrical specimens of 210 kg/cm² mix design with PET plastic and glass, of which three of each type will be tested at 7 days, 14 days, 21 days and 28 days to the compression test.

Methods, Techniques and Instruments for Data Collection.

The techniques used to collect data and results will be field observation and laboratory tests.

The tools we will use to process the data obtained are the use of software such as Excel, the Peruvian regulations and ACI, for an optimal result.

Processing for data analysis.

In the case of the new concrete, in the articles reviewed, we first tested the aggregates we are going to use, we will perform granulometric tests to determine the granulometric curve using the HUSES, fineness modulus (fine aggregate), humidity and absorption.

For cement, we will use type I and fineness modulus. Subsequently, new materials such as ground glass and PET plastic will be added. The mix design will be using the ACI method.

Afterwards, the new concrete specimens will be cured and then broken at 7 days, 14 days, 21 days and 28 days. Finally we will be able to know if the results we have obtained are satisfactory and if they fulfill our proposed objectives.

Results of Pet Plastic for Concrete Production.

Jorge Elías, Sánchez Julio and Reyna Cesar, from the Universidad Nacional de Trujillo, obtained the following results after the tests carried out.

The following tables show that concrete containing 5% PET achieves a strength of 459.26 kg/cm², higher than the strength of normal concrete. This means that PET, at this percentage, improves the compressive strength of concrete because it has good physical and mechanical properties. The specimens were prepared according to NTP 339.033. The specimens were then subjected to the curing stage in accordance with Peruvian Technical Standard 339.033. After the curing stage (28 days), the compression test was performed according to ASTM C39.

Table 3

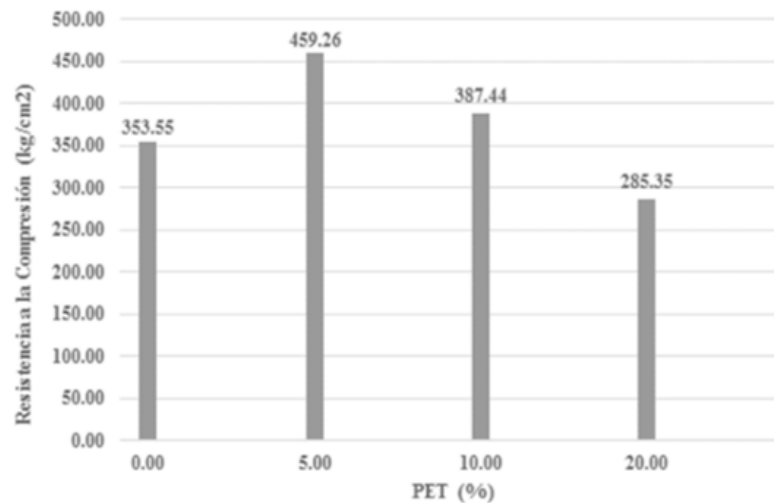
Resistencia a la compresión añadiendo PET }

Pet (%)	Compressive Strength (kg/cm ²)	Average Compressive Strength (kg/cm ²)
0	356.9	353.55
	353.25	
	350.5	
5	458.87	459.26
	456.25	
	462.65	
10	387.49	387.44
	386.5	
	388.33	
20	285.52	285.35
	283.3	
	287.22	

Source: Own elaboration

Tabla 4

Gráfica de resistencia a compresión versus % Pet añadido



Source: Vicente Flores Alex, Victor Jimenez

Calmet Cossio, Mario Félix, a graduate of Universidad César Vallejo, after performing a series of tests to determine compressive strength, obtained the following results. The specimens after 28 days the sample gives as a result that the higher the amount of addition of ground PET on

the sample, the compressive strength will decrease, which indicates that in order to obtain favorable results a 5% addition of Pet should be considered.

Results of ground glass for the production of concrete.

Arieta Padilla, in his thesis, Hormigón reforzado con vidrio molido y su relación con la resistencia a la compresión para controlar cracks y fisuras por contracción plástica, obtained the following results.

Tabla 5
Compressive strength by adding ground glass

RESISTENCIA A LA COMPRESIÓN (kg/cm ²)		% de vidrio molido			
Edad (días)	Diseño patrón	Vidrio verde		Vidrio marrón	
		1%	5%	1%	5%
3	204	226	183	228	180
7	279	283	252	286	247
14	319	322	288	328	293
28	326	332	302	342	306

Source: Own elaboration

Due to the results of the compression tests, the green and brown ground glass at a lower proportion increases the design strength, with the brown coloring contributing more than the green because its different chemical composition influences the increase of the design.

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