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Ecology, construction, and innovation: An alert towards change

Ecología, construcción e innovación: Una alerta al cambio

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The environmental damage caused to the planet is largely due to the pollution left behind by the misuse of debris, a large ecological footprint, the deforestation of important spaces due to the need to build, and bad practices within civil engineering. It is known that this problem is worldwide, but the most appropriate in our context and analysis is to focus on Colombia. A secondary objective of this article is to raise awareness and provide possible solutions to a problem as extensive and complicated as pollution. At the end of reading the article, it will be shown that this problem does not only affect a few people but the country in general.

Keywords: Construction, debris, ecology, engineering, pollution

El daño ambiental provocado al planeta se produce en gran medida por la contaminación que deja la mala utilización de escombros, una gran huella ecológica, la deforestación de espacios importantes por la necesidad de construir, y las malas prácticas dentro de la ingeniería civil. Se sabe que esta problemática es a nivel mundial, pero lo más adecuado en nuestro contexto y análisis es centrarse en Colombia. Un objetivo secundario de este artículo es la concientización, y dar unas posibles soluciones a un problema tan extenso y tan complicado como lo es la contaminación. Al finalizar de leer el artículo se mostrará que esta problemática no afecta solo a unos cuantos sino al país en general.

Palabras clave: Construcción, contaminación, ecología, escombros, ingeniería

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Introduction

The general purpose of this writing is to talk about the pollution produced by the bad use of debris and the importance of having an ecological approach in the daily work of the Civil Engineer (Sruti, Anju, Sunil, & Shrihari, 2014; Zuo, Rameezdeen, Hagger, Zhou, & Ding, 2017). Pollution is so great that it is necessary to make a worldwide assessment of the magnitude of the damage done to the planet, a topic that this paper will not address to be so extensive (Sigler, 2014). Therefore, we will talk mainly about Bogotá and the engineering practices that are affecting the environment (Blanco et al., 2014; Franco, Segura, & Mura, 2016).

The body of this article was worked with different approaches that complement each other to reach the same conclusion, the purpose of the article is primarily to raise awareness and find a solution to this serious problem, also to end the indifference of people to these issues, that they reflect and realize that the world is deteriorating more and more and it is better to look for a solution now and not regret it tomorrow, the damage to the planet is evident, we cannot continue to allow this to happen, because if this problem continues, surely the planet will deteriorate so much that it will not be left where future generations can live (Cui & Caracoglia, 2016; Gueguen & Hamid, 2016; Kurgan, 2017).

The Civil Engineer has the responsibility to change his environment, to change his surroundings, to restructure his practices and most importantly to change his ideology. This is a re-focus on change, which will benefit everyone in general.

Is the engineer an advantage or a disadvantage?

A footprint on the planet

To begin with, it is necessary to define what civil engineering is: Civil Engineering is the branch of engineering that applies the knowledge of Physics, Chemistry, and Geology to the elaboration of infrastructures, mainly buildings, hydraulic and transport works, in general of great size and for public use (Giordani & Leone, 2017).

Now let's see what bad practice is in civil engineering: bad practice in civil engineering is caused by the lack of morals of some civil engineers and the negligence of the competent authorities and the engineer himself (Vasquez, 2015).

Use of inappropriate materials in civil practices. Some contractors and builders invest in unspecified or poor quality materials to save resources in the execution of projects. These, instead of mitigating the impact of the climate and the effects of traffic, cause the short-term deterioration of the works, high costs, and loss of working hours. An example of this sin is the constant deterioration of the slabs of the Transmilenio system in the trunk of Avenida Caracas and the Autopista Norte. The District is still repairing them (Goenaga, Paz, & Sandoval, 2011).

These bad practices leave a mark on the planet either on a large scale or a small scale, so one must have certain considerations regarding the damage that is being caused because every action reacts.

This footprint is known as the Ecological Footprint. The *Ecological Footprint*: is an indicator that measures the portion of land necessary for human life about its consumption. In other words, the Earth's capacity, measured in hectares, to absorb the waste generated by a person according to his or her portion of the Planet (UTP, 2017).

Once the term has been clarified, one can begin to evaluate how the engineer leaves his ecological footprint, thanks to his ideas of progress and development. But we have to take into account that the world of professions is too wide to cover all the different factors that characterize the ecological footprint, so we will cover the civil engineering sector, as it is a suitable branch to work on it. Talking about this topic is beneficial and will help to see how some processes are being done wrong in Colombia and see how in other parts of the world alternatives are implemented that seek to solve these problems and how these solutions can be implemented in Colombia.

It is worth noting that in civil engineering the lack of organization on the part of the different construction entities in charge of large projects and the lack of precaution/consideration of the problems that can be generated by various projects are the pillars of the great ecological footprint of these professionals and companies in the area.

The amount of waste generated by the sector as well as the number of resources consumed (energy, raw materials) throughout the entire life cycle (construction, operation, maintenance, and deconstruction) contribute decisively to the increase in the human ecological footprint. The objectives and requirements for the Integrated Management of Civil Engineering Projects have to change (Rodríguez & Fernández, 2010), otherwise, the problem will be constantly growing and after a few years, it will be very difficult to turn back.

A world without natural resources

The misuse of materials not only harms the planet but also reduces the life span of human beings because every day important natural resources are devastated and something is not done to restore these resources. A clear example is the trees that are used for wood processing. Now, could you imagine a world without trees?

Bearing in mind that, to be healthy, the world needs the help of the processes that are carried out by trees and because in the world trees are a visual and natural attraction, a world

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without them is almost unimaginable, one could come up with different situations of what a world without trees would be like, but there are so many different possibilities that it is very difficult to imagine the right one.

The planet is deteriorating more and more every day and the concern will always be the lack of answers to the following question: What will be left for our children or relatives in the future? Below are the implications for the environment of a world without trees and the benefits of controlled and responsible logging. Deforestation statistics vary depending on the research organization that publishes them; however, we know that they range from about 155,000 hectares lost annually to 326,000 hectares in the same period according to the National Forest Inventory (Cardona, Vela, & Martínez, 2015).

Chiapas alone loses 30,000 hectares of forest and jungle annually according to Global Forest Watch. In any case, these statistics show us that deforestation as well as illegal logging are extremely urgent problems that affect both those who live in forest communities and those who live in cities.

Trees, as they grow, absorb CO_2, and wood products store the absorbed carbon, thus contributing to climate change mitigation. A building or using wood products multiplies the time that CO_2 is kept out of the atmosphere. Also, if the wood is FSC certified, it is guaranteed that the forest from which it was extracted has been responsibly managed to ensure the regeneration and growth of new trees.

Forest products are found in many of the trade sectors such as construction or packaging. For example, in construction, steel production requires 24 times more energy than that needed to produce wood. Concrete can emit 0.14 tons of CO_2 per cubic meter produced, while an equivalent amount of wood absorbs and stores 0.9 tons, reaching the construction input with a negative carbon balance, reducing both energy input costs and greenhouse gas emissions.

On the other hand, in the packaging sector, paper and cardboard have the largest market share with 34% according to E&Y data. In a way, this is a positive sign in the sector, since packaging materials of forest origin compared to aluminum, steel, and other sources are less energy-intensive giving them a smaller carbon footprint. The vast majority of this type of packaging is also fully recyclable and biodegradable. However, we must not lose sight of the fact that the demand for paper worldwide is increasing and recycling processes are limited, so wood input is constantly needed as a production material. That is why responsible forest management is becoming an indispensable requirement in the industry both to ensure supply and to maintain the attributes that forests provide (Administración Forestal (FSC), 2017).

Debris, increased ecological footprint

Since half the world does not find a solution to the disposal of debris and/or waste that arise constantly, day after day since the world of construction and civil infrastructure, is a world in constant motion, it is decided to proceed to dump them in the first place found, a matter of irresponsibility and lack of professionalism for which in the future we will be suffering.

Thanks to this bad distribution of highly polluting materials and taking into account that little by little the green areas of the planet are being exhausted to obtain from the extracted resources, more materials that possibly in the future will be discarded without control, thus becoming part of the great mass of waste, rubble, and debris. This becomes a harmful cycle. The generation of waste from Construction and Demolition is closely linked to the activity of the construction sector, as a result of the demolition of buildings and infrastructure that have become obsolete, as well as the construction of new ones and the little management that is given to these (Romero, 2006), is one of the main problems in all this mess of negative effects caused by the Civil Engineer. So much so that rigorous studies have had to be done on the final destination of the waste and the use that professionals and companies make of the rubble and structural waste.

Well, it is necessary to clarify several key concepts that arise with the passage of the reading, because if we talk about waste in construction it is important to know what it is: Construction and demolition waste are considered those that are generated in the urban environment and are not within the commonly known as Urban Solid Waste (domestic and commercial waste, mainly), since its composition is quantitatively and qualitatively different. This is waste, basically inert, made up of: mixed earth and aggregates, stones, remains of concrete, remains of asphalt pavements, refractory materials, bricks, glass, plastics, plaster, iron, wood and, in general, all waste produced by the movement of land and the construction of new buildings and infrastructure works, as well as those generated by the demolition or repair of old buildings (Romero, 2006).

The poor management of waste materials and debris is an important factor in the ecological footprint caused by the Civil Engineer because either a few materials or simple materials but in large quantities leave a negative effect. After all, in the typical materials of infrastructure projects such as asphalt mixtures, cement, lime, steel, and other elements, emission factors can be achieved not only related to energy consumption, but also emissions independent of energy (Fernández et al., 2010).

Not everything can be bad in these processes, because the Civil Engineer would not have so much acceptance in the world and society if in all cases they did things wrong. After all, well a solution that has been given to the excess of materials and waste is its accumulation in selected landfills

in specific points, but to know how all these wastes and variety of materials end up, we can see that the composition of construction and demolition waste, varies according to the type of infrastructure in question and reflects in its majority components, the type and percentage distribution of the raw materials used by the sector, although it must be taken into account that these may vary from one country to another depending on the availability of the same and construction habits.

Minority materials, on the other hand, depend on a much wider range of factors such as the climate of the place, the purchasing power of the population, the uses given to the building, etc (Romero, 2006). Knowing these factors, a brief analysis can be made of the quantity and different types of materials that can be found in the demolition processes of constructions and buildings.

The waste arriving at the landfills contains 75% of rubble broken down into various materials (Fig. 1).

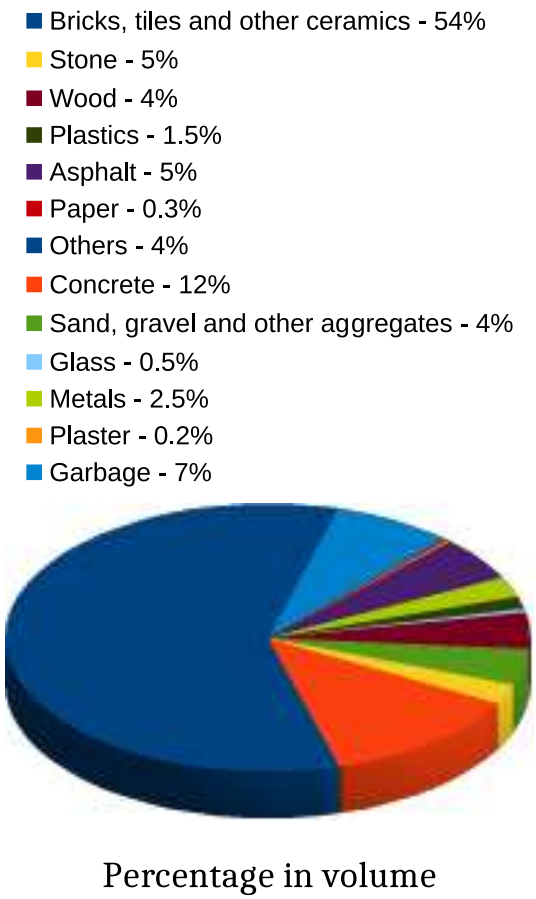

Figure 1. Percentage in volume of material deposited in landfills (modified) (Romero, 2006).

An example of the bad storage of the debris can be seen in the current problem in Cali, Colombia. For many years now, the riverbanks, streets, and wetlands of the town have been turned into garbage dumps. The Municipality is betting on the El Tejar Cartago property, but its owners say it is not available.

In the absence of a municipal dump, the streets, riverbank, and wetlands of Villa de Robledo have become a dumping ground for all kinds of waste. According to community complaints, the largest illegal dumps are concentrated in the sectors of La Invasión, the road to Santa Ana, la Madre Vieja, la Tierra del Olvido, and Puente Bolívar. This was confirmed by Héctor Fabio Muriel, an inhabitant of La Española, who assured that the neighboring road has been converted into a warehouse for construction materials and that (although it is cleaned up, they immediately reappear).

The main reason for this situation is that Cartago does not have an official dump, even though in 1994 the Ministry of the Environment issued Resolution No. 541, ordering municipalities to select a site for the disposal of these materials. According to Carolina Gómez, an official of the CVC's North DAR, the city's Territorial Ordering Plan, POT, established three sites as viable: Tejar La Esperanza, Tejar La Raya and another located on the road to Zaragoza. However, during the construction of the dual carriageway on its way through Cartago, these areas were used, so the project was again merged in turn, Luis Eduardo Aguado, Secretary of Municipal Planning, explained that in 2010 10 possible lots were proposed to the CVC and four were declared viable, but that no agreement could be reached with their owners. He added that the current administration hopes to use El Tejar Cartago as a dump, a piece of land located on the road to Cali, next to the Villasol Recreational Center.

However, a representative of the owners of this property assured to Cartago Hoy that the lot is not available for this activity and that they have already expressed it to Planeación. Carlos David Taborda, Undersecretary of the Environment of the Municipality, responded to the denial expressed by the representative of the property, saying that the Administration is establishing agreements with the owners (El País, 2012).

Problems and failures

Study equals protection

Today's engineer must be someone more prepared, someone with clear and defined bases and knowledge, for this reason having weak or poorly made structures that fall short of the requirements, are not suitable for implementation in an environment that seeks to leave the failures and overcome, this is largely due to lack of knowledge, professionalism, and preparation.

There are different factors, problems that the civil engineer must know and be prepared to avoid that these factors alter their structures and/or constructions, as well as there are factors that the engineer knows and cannot avoid no matter how much he knows or simply because there are

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not enough tools to appease the damage of these problems (Martínez, Montiel, & Jacinto, 2016).

As it has been already mentioned, the civil engineer must have clear knowledge, being a professional in charge of so many tasks, in so different areas as they can be, construction of roads, houses, buildings, structures, bridges, among others, likewise, the required knowledge is extended in different areas, one of them is the environmental knowledge because the environmental education must be a formative process using which it is looked that the individual and the community take conscience of the forms of interaction between the society and nature so that they act integrally and rationally with their means which is only possible through massive mechanisms of communication (El Tiempo, 1998).

The lack of education in this environmental sense is one of the key factors for bad construction practices, since the methodologies that differentiate some engineers from others leave this factor aside, which reflects the lack of environmental and ecological bases.

An error such as not knowing the topographical, seismic, and geographical data of the land on which it is to be built is a direct step to a structural disaster that produces subsequent environmental problems such as the demolition of obsolete structures by earthquakes. An example of the lack of knowledge of environmental factors is that More than 80% of the population of Venezuela lives in areas with seismic threats, and 45% of the low-cost housing that is built annually is built by the informal sector, without any technical support to guarantee its safety. The main cities of the country are the most vulnerable and among them, Caracas, the capital, seat of the public powers and the political and financial powers of the nation, has, due to its geological characteristics, service and roads, one of the most unfavorable conditions in case of emergency (Marrero, 2017). In the same way that these faults occur in Venezuela, they also occur in Colombia, if we take Bogotá (the capital of Colombia) as an example since the great majority of it is built on swampy land, which causes a poor response of the soil to the loads imposed on it.

The different zones with the highest seismic risk in Colombia can be exemplified with a geographic scheme (Gerdau Diaco, 2012), where these zones can easily be identified, where it should not be built on a large scale or if it is the case with greater security and performing a much stricter and rigorous process in each construction process.

But of course, this lack of knowledge is present in people without sufficient qualifications in the area, however, this problem can appear both in graduates of the civil engineering profession and in technologists or simply in builders outside professional studies.

Continuing with the lack of technical knowledge, and the lack of application of the same that produce different consequences and weaknesses in the practices that have been made in Colombia, ignoring the fact that in these studies and works not only the Civil Engineer intervenes.

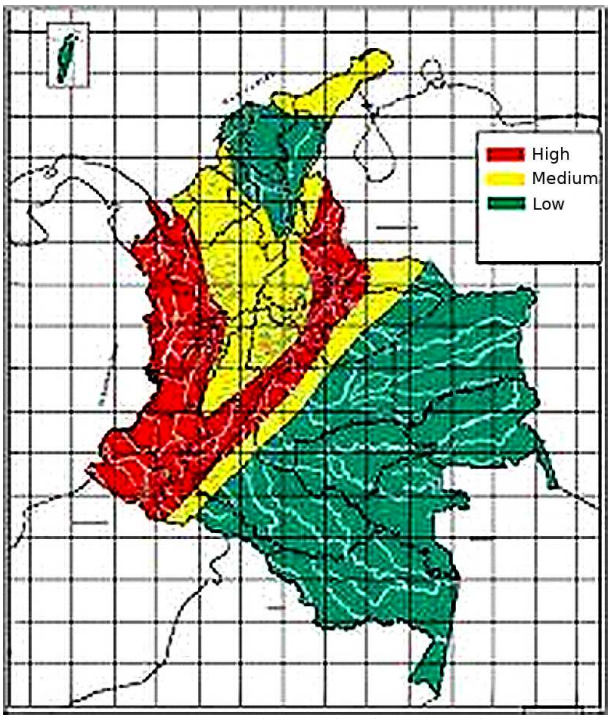

Figure 2. Areas with seismic risk in Colombia (Gerdau Diaco, 2012).

Studies have shown that the environmental situation in Colombia is characterized by an acute deterioration of the physical-biotic and social environment of the different economic processes that in Colombia have been understood as developed during the last fifty years. The deterioration that translates into losses of natural potential, the disappearance of natural resources, the degradation of settlements, chronic poverty, the accumulation of wealth, corruption, violence, insecurity and insurrection; situations that in turn generate greater environmental deterioration in a vicious circle that is difficult to break and that continually moves towards more critical situations.

The appearance of processes that are difficult to reverse, such as the urbanization of soils with agricultural potential in the Sabana de Bogotá and in the Valle del Cauca, the 90 percent reduction in fishing in the Magdalena River, the desertification of parts of the Valle del Cesar, and the mercury poisoning of the beds of the Cauca and San Juan Rivers, the loss of biodiversity in the Valle del Cauca, the Middle Magdalena and the foothills of the plains, the almost total destruction of the dry tropical forests on the Atlantic coast, the contamination of the coral reefs with agrochemicals and the imbalance of the network of cities with the formation of a slum metropolis of 7 million inhabitants to 2.650 meters above sea level (El Tiempo, 1998). This proves

that environmental problems are not only caused by civil engineers.

Ignorance is optional

There are several institutions, universities, agreements and/or faculties, willing to train quality professionals, professionals who are at a sufficient level to be able to satisfy the needs of a population scientifically and analytically, while offering them security and space of comfort, avoiding and preventing disasters, catastrophes or tragedies (whether these are avoidable, such as those caused by man, or inevitable, such as natural disasters). In such a way that the projects of the previously trained professionals guarantee spaces that promote a better quality of life and a higher quality than the one before the intervention of the professionals in charge. However, there is the fact that not all professionals graduate with the required level, this for several reasons, one of them can be the lack of reading and culture, since someone who reads is someone who is informed. An example is the Regime of Civil Responsibility of Constructors in Colombia (Solarte, 2014), which gives the Civil Engineer general guidelines to develop a good construction process.

Professionals can make mistakes because they want to cover more than they can, thus ignoring details that, although they may seem small, are catastrophic and their final result is proportional to the error. Ignoring a process or skipping the process to give a faster answer is not an act of a true professional, but unfortunately, that is what happens in some cases.

For example, satisfying the need for housing leads to a series of constructive actions that include the use of unsuitable land for habitation, the use of urban buildings in poor conditions, and widespread self-construction, among other ways of satisfying an unsatisfied demand. Thus, with housing, there is a diversity of risk conditions derived from both the construction systems and the financial procedures, the degrees of institutionalization and formalization, or the legalization of land use. Both the location in high-risk territories and the low quality of materials, their inadequate use, and the lack of knowledge of the techniques imply the construction of shelters that can become death traps. Examples of this are both the construction in adobe or bahareque, some very old, but other recent, as well as the modern constructions in blocks and reinforced concrete, in which the structural reinforcement is not well designed in terms of all the threats that it will have to face or where the constructive procedures weaken the capacity of the materials without this being evident in their external appearance (Argüello, 2004).

The mistakes that can be made by leaving out essential knowledge are easy to identify, but what happens when the professionals who graduated from these institutions and/or faculties are not competent enough? This question arises after seeing facts such as the flooding of a subway parking lot two or three months after its construction or also in the collapse of a building with only 10 months of useful life.

A case closer to reality was the unfortunate sudden collapse of the Space Building in Medellín, subjected only to service loads, and the severe structural damage found in several other buildings in Medellín (SCI, 2014).

These errors are under certain factors that are complicated to analyze, however, the law should be attentive to all these failures, since without knowing yet the final report of the investigation in progress by the University of the Andes, an entity designated by the Mayor's Office of Medellin to evaluate the processes of design and construction and the quality of the materials used in this building, there is a coincidence in the thinking of the structural engineers that if the current regulations had been complied with, this unfortunate disaster would not have occurred. All this implies that the authorities must investigate thoroughly if they find any professional malpractice, punish the guilty parties in an exemplary manner, and verify that it was not a frequent practice that has other constructions in risk conditions (SCI, 2014).

Reconciliation or perdition

The Civil Engineer must make many important decisions, not only for himself but also for a population and in most cases, a fairly large population, so every decision he makes is crucial for the welfare of both people and the environment where he builds and this is where the importance of having an ecological approach when carrying out construction projects comes into play, clarifying that we can define an infrastructure construction project as the set of non-repetitive, unique, time-bound and formally organized actions that use RESOURCES (people, companies, machines, tools, materials or money) necessary to achieve that material goal. Given that the PROJECT is the obligatory starting point of any infrastructure work, to assess its quality it is very important to establish, not only the technical-economic characteristics of the project itself but also the application of appropriate project management methods (Barbara, 2003).

Making the ecological focus in the development of architectural and structural projects is of vital importance for the Civil Engineer since this will decide how well seen his work will be by the environment and society, how useful his work will be for both human and natural life, and will also decide how long its life of use will be, if too long (because it is coupled with the environment) or too short (because it intervenes in natural processes that go against this type of work). To determine what actions have been done well and what actions are being used to safeguard resources, and even more important to maintain a link with the environment, it is

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necessary to take into consideration the following headings, which will largely determine whether the Civil Engineer is doing things well or definitely with his mistakes is doomed to failure and environmental and ecological abuse.

New approaches to construction

A general review of the problems that have been addressed may be the misuse of resources and the poor distribution of the debris, however, the following conclusions can be reached:

- A great amount of energy is consumed by the fuel used in the extraction, processing, and transport equipment of the different materials such as clay, lime, gypsum, stone, sand, among others.
- The incorrect selection and exploitation of the quarries, transformations of the natural relief, affectations to the flora and fauna and the degradation of soils, erosion, and affectations to the landscape due to the non-restitution of the vegetable layer.
- Air pollution by dust, noise, and emission of smoke and gases, especially in the production of concrete and asphalt. In this last case, the production of hazardous waste is also added.
- Affecting biological diversity by clearing of vegetation and loss of species habitat (Rosario, 2005).

But as mentioned from the beginning, not all practices performed by civil engineers are disastrous and harmful, as they work largely to safeguard and protect lives, provide spaces for public and common use. One of the reasons for the existence of the Civil Engineer, as its name indicates, is to engineer, innovate and improve processes, structures, constructions, and projects.

And as not everything is bad and pejorative, it is necessary to begin to expose all the pertinent and adequate actions that are made and are being made around the Civil Engineer, for example, some guides and documents sensitize the reader, directed especially to builders and engineers.

An example of the documents is the Guide to Good Environmental Practices in the Design, Construction, Use, Conservation and Demolition of Buildings and Facilities which states the following (Botella, 2017): The construction sector presents a wide range of possibilities for applying environmental initiatives in the different phases, activities, and operations that arise throughout the design, execution, demolition, and maintenance of a building.

The incorporation of environmental, social, and economic criteria is an evident necessity to advance towards a sustainable city model. Therefore, the City Council, through the Environmental Management Area, being aware of these opportunities to advance on the path of sustainability in the field of construction, has worked on various initiatives, for several years, to collect measures to reduce environmental impacts arising from the operations of the implementation and maintenance of works: effect on the soil, air emissions, consumption of natural resources and construction materials, waste generation, discharges, etc (Botella, 2017).

These ecological and environmental ideas in construction and as such in civil engineering, have already been happening in different places in the world, there are even countries that support and back the use of eco-friendly techniques and methods.

Norms for a salvation

Although there are institutions that train competent professionals and although there are ecological construction thoughts, there are people who due to lack of resources or economic problems have the need to work informally meaning that they do not work for anyone and their training was little or none.

As stated, the informal production of housing in Colombia has shaped the urban landscape of the country's major cities. Various authors state that between 20 and 50% of the houses located in Colombia's main cities were built informally, many of them by their owners or by commissioning construction masters, without complying with construction or urban planning standards; this translates, in most cases, into buildings with precarious living conditions and seismically vulnerable.

In this sense, since 2011 the Swiss Foundation for Technical Cooperation, Swisscontact, in alliance with various entities, has been operating a program in Bogotá that has focused on the design and implementation of strategies that can improve the quality of self-produced housing in sectors of informal origin (Agudelo, Ramos, & Merchán, 2014).

This is detrimental to the engineering industry and even more so to society, both visually and structurally. Thanks to illegal actions, or actions that are not certified, norms and regulations arise that modify the work and processes of civil engineers and related professionals. This is a profitable issue since they regulate and level the balance in terms of bad practices carried out by civil engineers.

An example of the above is the standards booklet provided by the Ministry of Environment and Development which states: The criteria for the selection of materials must include aspects such as aesthetics, performance, and availability at the local level, in addition to the conditions of environmental sustainability that they present in terms of local and global environmental impacts generated in their production and the energy incorporated. The environmental impacts generated by the production of construction materials are related to mining and natural resource exploitation, with the consequent loss of soil and subsoil, plant cover, biological diversity, water catchment areas, and runoff, among others. In the construction stage, waste and dumping to water sources are generated.

For the management of the environmental impact of housing production to be efficient in the use of materials, the selection criteria must be defined from the planning and design stage, taking into account the environmental impacts generated in its production and transport, as well as its characteristics and behavior of resistance, durability, maintenance requirements, inertia or thermal, acoustic and optical conductivity (ICONTEC, 2006). It is important to point out that, in the design stage, when preparing the construction plans and specifications, special care must be taken to include all the definitions and details of the materials to be used, so that these applications can be implemented practically and effectively in the construction process. Faced with this situation, the basic objectives of sustainability are set out, which frame the definition of the criteria to be applied (MinAmbiente, 2012). Tables 1 to 9 detail these criteria.

Alternatives and materials

Fortunately, there are people with very good ideas, people who contribute their knowledge for the welfare of others, there are even organizations that promote these ideas and disseminate them, which in general terms is very useful for civil engineers because it makes it easier for them to think about how not to damage the environment and alter nature.

Several of these ideas are in the reuse of various materials that are easy to get as these materials are very common. In most cases, they are materials extracted from large, easily accessible sources. And in reality, we must be careful in how we use the materials and the place where they are destined, by not taking into account the previous considerations it happens that the residues that are produced as a result of the productive activity of many industries, suppose a problem of storage and elimination for these and a serious environmental and ecological problem for the alive beings. On the other hand, in today's construction, it must be a priority to take into account the principles of sustainability and respect for the environment. For this reason and joining these two concepts, it is very interesting to produce materials for construction based on the industrial waste that otherwise would be uselessly stored in landfills (Martinez, Martinez, & Hernandez, 2017; Oreja, 2011).

For these reasons and many more, we propose the creation of a new constructive material, called ecoladrillo, inspired by the traditional adobe and that replaces the conventional brick. For this purpose, marginal soil is used which has not been used until now for the manufacture of bricks. As commercial additives, cement is used to make the reference combinations and, the less usual but equally efficient hydraulic lime. As a resistant additive are used the ashes of rice husks and as a structuring additive also rice husks. The addition of these last two residual additives means the reduction of a great environmental impact since the ashes coming from the biomass generated by the combustion of the remains of the rice harvest, remain for millions of tons in landfills all over the world.

Until the definition of this product, four experimental phases have been carried out as a new additive has been added to the sample. For the characterization of each combination proposed in each phase, the simple compression resistance test, the absorption test, and the icing test have been carried out. Besides, the weight losses that occur during the curing time and the resistance losses that occur after immersion and after the ice/thaw cycles have been monitored. All combinations studied have been carried out at three relatively low levels of compaction (1, 5, and 10 MPa). Nevertheless, the realization of these bricks at 1 MPa is discarded, mainly because the structure of the same ones is excessively open. Later, in the penultimate phase, combinations at 5 MPa have been discarded since, contrary to what is observed at 10 MPa, no significant improvements are produced.

The results obtained are satisfactory. Natural hydraulic lime is a sustainable additive with the capacity to develop resistance. Also, combining the lime with the rest of additives the differences with the reference combination, made with cement, are minimum. The ashes of rice husk suppose a great additive that strengthens to more than double the resistance of the sample with ashes that without them, demonstrating that they favor remarkably the development of the pozzolanic reactions. Rice husks decrease by more than 10% the density of the combination with only commercial additive. In addition to a good appearance, the Eco-Brick responds to ecological and sustainable criteria since it requires a low level of energy for its manufacture and eliminates the emission of CO_2 into the atmosphere since it is a brick that does not require cooking (Cabo, 2011).

Like the previous example of the eco-bricks, many ideas are already being implemented in different parts of the world to mitigate the problems that are caused by progress.

Conclusions

We conclude the main problems caused by bad practices carried out by civil engineers thanks to X or Y reasons, all of them directly or indirectly affect the environment, nature, thus altering the health of the planet in general. It is time to change the way we take care of and protect the world, around man, thinking about what will be left for future generations, because it is clear that today's actions will affect tomorrow's man.

It is important to take care of the planet since it is the main source of life. The Civil Engineer is the source of progress and structural development, to such an extent that it is in his hands to leave the planet in good condition for future generations to inhabit.

In general, measures are already being taken in the matter, creating organizations, writing norms and restrictions,

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Table 1
Material use sheet part A (MinAmbiente, 2012).

FICHA No. 18	EJE TEMÁTICO: MATERIALES	
	OBJETIVO 1	
	RACIONALIZAR EL USO DE MATERIALES	
	CRITERIO	
	M-1	USO DE MATERIALES REGIONALES
1. DESCRIPCIÓN		
Aprovechamiento de los materiales disponibles en la zona donde se desarrolla el proyecto, incluyendo los tradicionales y culturalmente arraigados, emblemáticos o representativos, producidos de manera sostenible, garantizando la restitución paisajística y la renovación de los recursos naturales.		
2. ACCIONES TÉCNICAS		APLICABILIDAD
EN EL DISEÑO		
Considerar la oferta y disponibilidad de materiales de producción local, en cuya explotación y manufactura se apliquen las normas de protección y manejo ambiental, la restitución del medio natural y la persistencia de la reserva de los recursos. ✓ Agregados pétreos de explotaciones cercanas legales que implementen restitución y estabilización del suelo, restauración de ecosistemas y reposición de la vegetación. ✓ Material de suelo y fibras naturales seleccionadas y tratadas para agregados de mezclas de concretos para bloques o tabiques. ✓ Adobes y bloques producidos mediante prensado o mezcla de cemento. No se recomienda el uso de ladrillos producidos en hornos artesanales, cuya emisión de contaminantes es muy elevada. ✓ Maderas cultivadas o explotadas de manera legal, con procesos de reforestación y protección de la biodiversidad. ✓ Guaduas, en zonas como el Eje Cafetero, norte del Valle del Cauca, Antioquia, Huila y Santanderes, procedentes de plantaciones o reservas de explotación legal con restitución del medio natural y de recuperación del recurso. ✓ Cañas, pajas y fibras vegetales extraídas con medidas de mantenimiento y protección de la reserva. Estos materiales deben tener tratamiento de deshidratación, inmunización y manejo fitosanitario.		DESEABLE

creating awareness in the people and institutions in charge of educating and training civil engineers, and even ecological materials are already being implemented to reduce the pollution created by the debris of the constructions made by the Civil Engineer.

Taking into account all the above considerations it is important to clarify that to begin to see these changes in Colombia should be promoted ideas such as the ecoladrillo, environmental management plans in buildings, buildings that are oriented to care and respect nature creating an intimate relationship with this, this also focused on the mission of educating and training quality civil engineers who meet the environmental and professional requirements that this planet and this society needs.

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Table 2
Material use sheet part B (MinAmbiente, 2012).

EN LA CONSTRUCCIÓN:	
Se deben exigir las certificaciones de origen, que den cuenta de la procedencia legal de los materiales a utilizar.	PRIORITARIO
EN EL USO Y MANTENIMIENTO	
Utilizar las mismas tecnologías y materiales regionales al realizar modificaciones o ampliaciones.	DESEABLE
CRITERIO M-1 USO DE MATERIALES REGIONALES	
3. BENEFICIOS	
Uso de materiales de menor impacto ambiental en su producción y utilización. Aprovechamiento de los recursos locales y las condiciones climáticas y ambientales del entorno. Facilidad de reincorporación de los materiales al medio natural al finalizar la vida útil de la edificación. Disponibilidad de materiales locales para reparaciones, mantenimientos o ampliaciones futuras, con las mismas características de los materiales originales. Aprovechamiento de los conocimientos sobre el manejo y uso adecuado de los materiales de su localidad. Disminución de consumo energético por reducción de requerimientos de transporte.	
4. APLICABILIDAD	
Es de fácil aplicación, ya que la utilización de materiales encontrados en la región donde se desarrolla el proyecto genera ahorro y disminución de impacto ambiental por traslado y transporte	
5. NORMATIVA	
Normativa ambiental relacionada con la extracción legal de madera y materiales pétreos, la cual es de obligatorio cumplimiento, como la licencia ambiental para explotaciones mineras. Resolución MAVDT 1555 de 2005, crea el Sello Ambiental Colombiano Pacto Intersectorial por la Madera Legal, (agosto de 2009) para la explotación y comercialización maderera en Colombia, suscrito entre los gremios explotadores y procesadores forestales, los principales distribuidores, transportadores y agremiaciones de consumo, las instituciones de protección ambiental y los organismos de regulación y control estatal, para hacer de la industria maderera un ejemplo de sostenibilidad manejada integralmente.	
6. INCENTIVOS PROPUESTOS	ENTIDADES
Implementar la certificación de procesos de explotación y producción ambientalmente sostenibles de materiales.	Desarrolla Ministerio de Ambiente y Desarrollo Sostenible.
Desarrollo de acciones intergremiales y de políticas para impulsar la producción ambientalmente sostenible de materiales disponibles.	Desarrolla Ministerio de Ambiente y Desarrollo Sostenible.

Table 3
Material use sheet part C (MinAmbiente, 2012).

FICHA No. 19	**EJE TEMÁTICO: MATERIALES**	
	OBJETIVO 1	
	RACIONALIZAR EL USO DE MATERIALES	
	CRITERIO	
	M-2	APLICAR LAS PROPIEDADES FÍSICAS DE LOS MATERIALES
1. DESCRIPCIÓN		
Selección de materiales y sistemas pasivos para el manejo de las condiciones de temperatura, iluminación y acústica del edificio, de acuerdo con las características y propiedades físicas, masa o inercia térmica y, comportamiento lumínico y acústico, aprovechando su aporte para la reducción del consumo energético y mejorar las condiciones de climatización interior.		

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Table 4
Material use sheet part D (MinAmbiente, 2012).

2. ACCIONES TÉCNICAS	APLICABILIDAD
EN EL DISEÑO	
Definir y especificar los materiales, indicando espesores requeridos, composición y funcionamiento de los sistemas pasivos, aislamientos y tratamientos de superficies y utilizando sus características físicas para promover la climatización natural: ✓ Material de suelo y fibras naturales seleccionadas y tratadas para agregados de mezclas de concretos para bloques o tabiques. ✓ Materiales con baja conductividad y baja densidad utilizados como relleno térmico y acústico en juntas de construcción o en muros dobles entre estancias. ✓ Materiales con alta porosidad, permeabilidad o con cavidades, permiten transpiración del ambiente interior, manejando la humedad o condensación. ✓ Materiales según su transparencia y conductividad, color o textura, permiten o rechazan el paso de luz, calor o sonido, para producir iluminación, acumulación de calor, aislamiento o amortiguación térmica o sonora. ✓ Cámaras generadas por cielorrasos descolgados, muros paralelos o de doble superficie, abiertos para empuje del aire o cerrados como amortiguamiento térmico o sonoro. ✓ Muros Trombe, que impulsan el aire interno mediante el calor solar, aplicables como calefactores inyectando aire o refrigerantes. ✓ Ductos y termosifones con efecto chimenea que impulsan el aire por diferencia de presiones aerodinámicas o convección. ✓ Terrazas o cubiertas con vegetación, funcionan como amortiguadores térmicos y acústicos, y aportan áreas verdes renovadoras del aire. ✓ Placas-estanque acumuladoras o aislantes de calor solar, según se permita o evite la evaporación o la emisión de calor en horas de la noche.	**DESEABLE**
Implementar el uso de ecomateriales: ✓ Módulos de mampostería que, sin mayor incremento en la cantidad de arcilla, desarrollan geometrías con cavidades de acumulación de calor (p. ej. Termoarcilla ECO® y Climablock® en España). ✓ Prefabricados de concreto con doble pared o aislamientos amortiguadores. ✓ Bloques cerámicos o de concreto con fibras naturales o artificiales o agregados recuperados de demolición.	**DESEABLE**
EN LA CONSTRUCCIÓN:	
Generación de espacios de uso múltiple que incrementen la eficiencia de los sistemas implementados, mediante el uso de divisiones livianas, fijas o móviles. Espacios amplios y versátiles de uso múltiple, que puedan iluminarse, ventilarse o climatizarse con menos elementos, impulsando a su vez la vocación productiva de la vivienda a nivel personal o familiar, fomentando el trabajo y el esparcimiento en casa.	**PRIORITARIO**
EN EL USO Y MANTENIMIENTO	
Incorporar en el manual de mantenimiento para el usuario las recomendaciones de uso, control y mantenimiento de los sistemas implementados.	**PRIORITARIO**

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Table 5
Material use sheet part E (MinAmbiente, 2012).

CRITERIO M-2. APLICAR LAS PROPIEDADES FÍSICAS DE LOS MATERIALES
3. BENEFICIOS
Reducción de los impactos ambientales indirectamente causados a través del consumo de energía eléctrica para climatización de los espacios, al generar condiciones naturales de confortabilidad. Reducción de costos ambientales en el tratamiento de desechos, al promover la construcción con materiales ligeros y de ejecución limpia.
4. APLICABILIDAD
El mayor costo inicial en los casos en que se incrementa la cantidad de material a usar, como sistemas de cámaras, ductos o dobles superficies, será amortizado progresivamente por el ahorro en energía eléctrica para climatización.
5. NORMATIVA
No hay normativa acerca de las aplicaciones bioclimáticas.

Table 6
Material use sheet part F (MinAmbiente, 2012).

6. INCENTIVOS PROPUESTOS	ENTIDADES
Programas de difusión y capacitaciones, desarrollo de prototipos de estudio y ensayos. Elaboración de tablas de coeficientes de transmisión o acumulación térmica y acústica.	Desarrolla SENA, Institutos de Investigación, Universidades e ICONTEC
Eliminación del Impuesto de Valor Agregado (IVA) en la adquisición de materiales producidos con materia prima recuperada de demoliciones, o con alto aporte en climatización, o un procedimiento de devolución y compensación de dicho impuesto, como incentivo a los constructores.	Reglamentación Gobierno Nacional y Congreso de la República
Implementación de concursos anuales de proyectos innovadores de vivienda, que incentiven la creatividad de los diseñadores hacia nuevas propuestas arquitectónicas.	Desarrollan Ministerio de Vivienda, Ciudad y Territorio y Ministerio de Ambiente y Desarrollo Sostenible

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Table 7
Material use sheet part G (MinAmbiente, 2012).

FICHA No. 20	EJE TEMÁTICO: MATERIALES	
	OBJETIVO 1	
	RACIONALIZAR EL USO DE MATERIALES	
	CRITERIO	
	M-3	MODULACIÓN DE ELEMENTOS DE CONSTRUCCIÓN

1. DESCRIPCIÓN	
Despiece y repartición de cortes de elementos de construcción con base en las especificaciones de uso y presentación del producto, para optimizar su utilización y reducir desperdicios.	
2. ACCIONES TÉCNICAS	**APLICABILIDAD**
EN EL DISEÑO	
Coordinar las dimensiones del proyecto con las de los elementos especificados, planteando el uso de unidades modulares que permitan reducir los cortes de material y su consecuente desperdicio: ✓ Ladrillos y bloques en elementos enteros, medios y cuñas, para producir los traslapos y empalmes de muros. ✓ Piezas de remate para muros, cumbreras, terminales o bases. ✓ Despieces de trozas o tiras de madera. ✓ Perfiles de acero de refuerzo y de aluminio, de acuerdo con la presentación comercial de los elementos, con aprovechamiento de segmentos de corte. ✓ Paneles modulares prefabricados y normalizados.	DESEABLE
EN LA CONSTRUCCIÓN:	
Disponer de los sobrantes de corte para reutilización o reciclaje, y eliminar la generación de segmentos cuya dimensión no sea aprovechable.	PRIORITARIO
Al realizar los pedidos, preferir el suministro de materiales procesados en planta, premezclados, despiezados o prefigurados, en cuyo procesamiento se garantice el reuso o reducción de desperdicios.	PRIORITARIO
Implementar el uso de cerramientos provisionales de obra, desmontables y reutilizables.	PRIORITARIO
EN EL USO Y MANTENIMIENTO	
Utilizar las mismas tecnologías y materiales al realizar modificaciones o ampliaciones.	DESEABLE

Table 8
Material use sheet part H (MinAmbiente, 2012).

CRITERIO M-2. APLICAR LAS PROPIEDADES FÍSICAS DE LOS MATERIALES
3. BENEFICIOS
Reducción de impactos por menor requerimiento de fabricación de elementos procesados. Coordinación de dimensiones de diferentes componentes de la construcción, e impulso a la fabricación en taller con producción controlada, eficiente y limpia. Eficiencia y economía en el aprovechamiento del recurso, con reducción de sobrantes por despieces y cortes planificados de elementos.

Table 9

Material use sheet part I (MinAmbiente, 2012).

4. APLICABILIDAD	
Coordinar las dimensiones del proyecto con las de los elementos especificados, planteando el uso de unidades modulares que permitan reducir los cortes de material y su consecuente desperdicio: ✓ Ladrillos y bloques en módulos y submódulos para ensamblajes y aparejos de mampostería. ✓ Paneles prefabricados con piezas de remate y cierre horizontal y de cubierta. ✓ Puertas y muebles modulares de madera laminada o prensados de madera plástica. ✓ Ventanas y puertas de aluminio pre-ensambladas.	
5. NORMATIVA	
No hay normativa acerca de la aplicación de este criterio, quedando sujeto al buen criterio de diseñadores y constructores en función de la eficiencia y la economía, para eliminar sobrantes y desperdicios.	
6. INCENTIVOS PROPUESTOS	**ENTIDADES**
Capacitaciones y entrenamiento práctico de personal de diseñadores y constructores para difundir métodos de despiece y corte de elementos.	Desarrolla productores, Asociaciones Profesionales e Institutos Educativos Técnicos y Profesionales