Tekhnê

Tecnología al servicio de la sociedad

Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Universidad Distrital Francisco José de Caldas
Facultad Tecnológica

Vol. 15 No. 2
July - December 2018
ISSN 1692-8407

Tekhnê

Tecnología al servicio de la sociedad

Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Volumen 15 - Número 2 - 2018
ISSN 1692-8407

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS
FACULTAD TECNOLÓGICA

Cubierta: The Dull Ice Flower, Gimnyeong Seonsegi Beach, Jeju Island (Corea del Sur)
Autor: Fredy H. Martínez S.

Contracubierta:
- Superior izquierda: Fissure and crack comparison (Callejas, N., Buitrago, J. and Moreno, D.)
- Superior derecha: Content of the EDA (Narváez, A., Riscanevo, K. and Guzmán, M.)
- Centro: Percentage in volume of material deposited in landfills (Guerrero, V. and Sánchez, W.)
- Inferior izquierda: Industrial tire grinding process data (Castellanos, V., Rodríguez, N. and Cárdena, K.)
- Inferior derecha: Environment and health: acid rain (Castellanos, V., Rodríguez, N. and Cárdena, K.)

Corrección de estilo español
Angélica Viviana Rendón Calderón

Corrección de estilo inglés
Fredy H. Martínez S.

Impresión
Imprenta Universidad Distrital Francisco José de Caldas
Formato 21.5 × 28 cm
Papel Bond 75 g
Tiraje de 70 ejemplares

Revista Tekhnê

La revista **Tekhnê** es una publicación institucional de la Facultad Tecnológica de la Universidad Distrital Francisco José de Caldas. Posee un carácter científico, y atiende a la comunidad nacional e internacional especialista en áreas de ingenierías eléctrica, electrónica, mecánica, de sistemas, industrial y civil. Publica resultados de investigación en inglés (artículos originales e inéditos), y está completamente abierta a especialistas de todo el mundo en calidad de autores y/o lectores. Es arbitrada mediante un proceso doble ciego, con rotación continua de árbitros. La periodicidad de la conformación de sus comités Científico y Editorial está sujeta a la publicación de artículos en revistas indexadas internacionalmente por parte de sus respectivos miembros.

Periodicidad

La revista **Tekhnê** posee una periodicidad semestral, coincidente con los semestres académicos de la Universidad Distrital. La publicación se realiza los meses de julio y diciembre. El primer volumen de la revista se publicó el primer semestre de 2003, manteniendo su regularidad hasta la fecha.

Misión

La revista **Tekhnê** tiene como misión divulgar resultados de investigación realizados en el área de la ingeniería, a través de la publicación de artículos originales e inéditos, realizados por académicos y profesionales pertenecientes a instituciones nacionales o extranjeras del orden público o privado. Propende por la difusión de resultados y su acceso abierto y libre.

Público objetivo

La revista está dirigida a docentes, investigadores, estudiantes y profesionales interesados en la actualización permanente de sus conocimientos y el seguimiento de los procesos de investigación científica en el campo de la ingeniería.

Forma de adquisición

La revista **Tekhnê** se puede adquirir a través de compra o canje.

Reproducción

Dirección postal

Prof. Fredy H. Martínez S.
Editor y director revista Tekhnê
Sala de Revistas, Bloque 5, Oficina 301
Facultad Tecnológica
Universidad Distrital Francisco José de Caldas
Transversal 70B No. 73A-35 sur
Teléfono: (571) 3238400 Ext. 5003
Celular: (57) 3005585481
Bogotá D.C., Colombia
E-Mail: fhmartinezs@udistrital.edu.co
Url: https://revistas.udistrital.edu.co/index.php/tekhne

T e k h n ê

Tecnología al servicio de la sociedad

Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Volume 15 - Number 2 - 2018
ISSN 1692-8407

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS
FACULTAD TECNOLÓGICA

Cover picture: The Dull Ice Flower, Gimnyeong Seonsegi Beach, Jeju Island (South Korea)
Author: Fredy H. Martínez S.

Back cover picture:
- Top left: Fissure and crack comparison (Callejas, N., Buitrago, J. and Moreno, D.)
- Top right: Content of the EDA (Narváez, A., Riscanevo, K. and Guzmán, M.)
- Middle: Percentage in volume of material deposited in landfills (Guerrero, V. and Sánchez, W.)
- Lower left: Industrial tire grinding process data (Castellanos, V., Rodríguez, N. and Cárdena, K.)
- Lower right: Environment and health: acid rain (Castellanos, V., Rodríguez, N. and Cárdena, K.)

Style correction in spanish
Angélica Viviana Rendón Calderón

Style correction in english
Fredy H. Martínez S.

Printed by
Imprenta Universidad Distrital Francisco José de Caldas
Format: 21.5 × 28 cm
Paper: Bond 75 g
Printing: 70 copies

Tekhnê Journal

Tekhnê journal is an institutional publication of the Facultad Tecnológica of the Universidad Distrital Francisco José de Caldas (Bogotá D.C. - Colombia). It has a scientific character and serves the national and international community specialized in the areas of electrical, electronic, mechanical, systems, industrial and civil engineering. It publishes research results in English (original and unpublished articles), and is completely open to specialists from around the world as authors and/or readers. It is arbitrated through a double-blind process, with continuous rotation of arbitrators. The periodicity of the formation of its Scientific and Editorial Committees is subject to the publication of articles in internationally indexed journals by their respective members.

Periodicity

Tekhnê journal is published every six months, coinciding with the academic semesters of the Universidad Distrital. It is published in July and December. The first volume of the journal was published in the first semester of 2003, maintaining its regularity to date.

Mission

The mission of **Tekhnê** journal is to disseminate research results conducted in the area of engineering, through the publication of original and unpublished articles by academics and professionals belonging to national or foreign institutions of public or private order. It aims at the diffusion of results and their open and free access.

Target audience

The journal is aimed at professors, researchers, students, and professionals interested in permanently updating their knowledge and monitoring scientific research processes in the field of engineering.

Form of adquisition

Tekhnê journal can be purchased, or exchanged.

Reproduction

Mailing address

Prof. Fredy H. Martínez S.
Editor and director Tekhnê Journal
Sala de Revistas, Bloque 5, Oficina 301
Facultad Tecnológica
Universidad Distrital Francisco José de Caldas
Transversal 70B No. 73A-35 sur
Phone: (571) 3238400 Ext. 5003
Cell phone: (57) 3005585481
Bogotá D.C., Colombia
E-Mail: fhmartinezs@udistrital.edu.co
Url: https://revistas.udistrital.edu.co/index.php/tekhne

Declaración de ética y buenas prácticas

Tekhnê
Tecnología al servicio de la sociedad
Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Revista Tekhnê
Universidad Distrital Francisco José de Caldas
Facultad Tecnológica

El comité editorial de la revista **Tekhnê** está comprometido con altos estándares de ética y buenas prácticas en la difusión y transferencia del conocimiento, para garantizar el rigor y la calidad científica. Es por ello que ha adoptado como referencia el Código de Conducta que, para editores de revistas científicas, ha establecido el Comité de Ética de Publicaciones (COPE: Committee on Publication Ethics) dentro de los cuales se destaca:

Obligaciones y responsabilidades generales del equipo editorial

En su calidad de máximos responsables de la revista, el comité y el equipo editorial de **Tekhnê** se comprometen a:
• Aunar esfuerzos para satisfacer las necesidades de los lectores y autores.
• Propender por el mejoramiento continuo de la revista.
• Asegurar la calidad del material que se publica.
• Velar por la libertad de expresión.
• Mantener la integridad académica de su contenido.
• Impedir que intereses comerciales comprometan los criterios intelectuales.
• Publicar correcciones, aclaraciones, retractaciones y disculpas cuando sea necesario.

Relaciones con los lectores

Los lectores estarán informados acerca de quién ha financiado la investigación y sobre su papel en la investigación.

Relaciones con los autores

Tekhnê se compromete a asegurar la calidad del material que publica, informando sobre los objetivos y normas de la revista. Las decisiones de los editores para aceptar o rechazar un documento para su publicación se basan únicamente en la relevancia del trabajo, su originalidad y la pertinencia del estudio con relación a la línea editorial de la revista.

La revista incluye una descripción de los procesos seguidos en la evaluación por pares de cada trabajo recibido. Cuenta con una guía de autores en la que se presenta esta información. Dicha guía se actualiza regularmente y contiene un vínculo a la presente declaración ética. Se reconoce el derecho de los autores a apelar las decisiones editoriales.

Los editores no modificarán su decisión en la aceptación de envíos, a menos que se detecten irregularidades o situaciones extraordinarias. Cualquier cambio en los miembros del equipo editorial no afectará las decisiones ya tomadas, salvo casos excepcionales en los que confluyan graves circunstancias.

Relaciones con los evaluadores

Tekhnê pone a disposición de los evaluadores una guía acerca de lo que se espera de ellos. La identidad de los evaluadores se encuentra en todo momento protegida, garantizando su anonimato.

Proceso de evaluación por pares

Tekhnê garantiza que el material remitido para su publicación será considerado como materia reservada y confidencial mientras que se evalúa (doble ciego).

Reclamaciones

Tekhnê se compromete responder con rapidez a las quejas recibidas y a velar para que los demandantes insatisfechos puedan tramitar todas sus quejas. En cualquier caso, si los interesados no consiguen satisfacer sus reclamaciones, se considera que están en su derecho de elevar sus protestas a otras instancias.

Fomento de la integridad académica

Tekhnê asegura que el material que publica se ajusta a las normas éticas internacionalmente aceptadas.

Protección de datos individuales

Tekhnê garantiza la confidencialidad de la información individual (por ejemplo, de los profesores y/o alumnos participantes como colaboradores o sujetos de estudio en las investigaciones presentadas).

Seguimiento de malas prácticas

Tekhnê asume su obligación para actuar en consecuencia en caso de sospecha de malas prácticas o conductas inadecuadas. Esta obligación se extiende tanto a los documentos publicados como a los no publicados. Los editores no sólo rechazarán los manuscritos que planteen dudas sobre una posible mala conducta, sino que se consideran éticamente obligados a denunciar los supuestos casos de mala conducta. Desde la revista se realizarán todos los esfuerzos razonables para asegurar que los trabajos sometidos a evaluación sean rigurosos y éticamente adecuados.

Integridad y rigor académico

Cada vez que se tenga constancia de que algún trabajo publicado contiene inexactitudes importantes, declaraciones engañosas o distorsionadas, debe ser corregido de forma inmediata.

En caso de detectarse algún trabajo cuyo contenido sea fraudulento, será retirado tan pronto como se conozca, informando inmediatamente tanto a los lectores como a los sistemas de indexación.

Se consideran prácticas inadmisibles, y como tal se denunciarán las siguientes: el envío simultáneo de un mismo trabajo a varias revistas, la publicación duplicada o con cambios irrelevantes o parafraseo del mismo trabajo, o la fragmentación artificial de un trabajo en varios artículos.

Relaciones con los propietarios y editores de revistas

La relación entre editores, editoriales y propietarios estará sujeta al principio de independencia editorial. **Tekhnê** garantizará siempre que los artículos se publiquen con base en su calidad e idoneidad para los lectores, y no con vistas a un beneficio económico o político. En este sentido, el hecho de que la revista no se rija por intereses económicos, y defienda el ideal de libre acceso al conocimiento universal y gratuito, facilita dicha independencia.

Conflicto de intereses

Tekhnê establecerá los mecanismos necesarios para evitar o resolver los posibles conflictos de intereses entre autores, evaluadores y/o el propio equipo editorial.

Quejas/denuncias

Cualquier autor, lector, evaluador o editor puede remitir sus quejas a los organismos competentes.

Code of ethics and good practice

T e k h n ê

Tecnología al servicio de la sociedad

Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Tekhnê Journal
Universidad Distrital Francisco José de Caldas
Facultad Tecnológica

The editorial board of **Tekhnê** journal is committed to ethics high standards and good practice for knowledge dissemination and transfer, in order to ensure rigour and scientific quality. That is why it has taken as reference the Code of Conduct, which has been established by the Committee on Publication Ethics (COPE) for scientific journal editors; outlining the following:

General duties and responsibilities of the editorial board

As most responsible for the journal, **Tekhnê** committee and the editorial board are committed to:
• Joining efforts to meet the readers and authors needs.
• Tending to the continuous improvement of the Journal.
• Ensuring quality of published material.
• Ensuring freedom of expression.
• Maintaining the academic integrity of their content.
• Prevent commercial interests compromise intellectual standards.
• Post corrections, clarifications, retractions and apologies when necessary.

Relations with readers

Readers will be informed about who has funded the research and their role in the research.

Relations with authors

Tekhnê is committed to ensuring the quality of published material, informing the goals and standards of the journal. The decisions of publishers to accept or reject a paper for publication are based solely on the relevance of the work, originality and pertinence of the study with journal editorial line.

The journal includes a description of the process for peer evaluation of each received work, and has an authors guide with this information. The guide is regularly updated and contains a link to this code of ethics. The journal recognizes the right of authors to appeal editorial decisions.

Publishers will not change their decision in accepting or rejecting articles, unless extraordinary circumstances or irregularities are detected. Any change in the editorial board members will not affect decisions already made, except for unusual cases where serious circumstances converge.

Relations with evaluators

Tekhnê makes available to reviewers a guide to what is expected from them. Reviewers identity is protected at all times, ensuring anonymity.

Peer review process

Tekhnê ensures that material submitted for publication will be considered private and confidential issue while being reviewed (double blind).

Claims

Tekhnê is committed to respond quickly to complaints and ensure that dissatisfied claimant can process all complaints. In any case, if applicants fail to satisfy their claims, the journal considers that they have the right to raise their protests to other instances.

Promoting academic integrity

Tekhnê ensures that the published material conforms to internationally accepted ethical standards.

Protection of individual data

Tekhnê guarantees the confidentiality of individual information (e.g. participant teachers and/or students as collaborators or subjects of study in the presented research).

Tracking malpractice

Tekhnê accepts the obligation to act accordingly in case of suspected malpractice or misconduct. This obligation extends

both to publish and unpublished documents. The editors not only reject manuscripts with doubts about possible misconduct, but they are considered ethically obligated to report suspected cases of misconduct. From the journal every reasonable effort is made to ensure that works submitted for evaluation are rigorous and ethically appropriate.

Integrity and academic rigour

Whenever evidence that a published work contains significant misstatements, misleading or distorted statements, it must be corrected immediately.

In case of any work with fraudulent content is detected, it will be removed as soon as it is known, and immediately informing both readers and indexing systems.

Practices that are considered unacceptable and as such will be reported: simultaneous sending of the same work to various journals, duplicate publication with irrelevant changes or paraphrase of the same work, or the artificial fragmentation of a work in several articles.

Relations with owners and journal editors

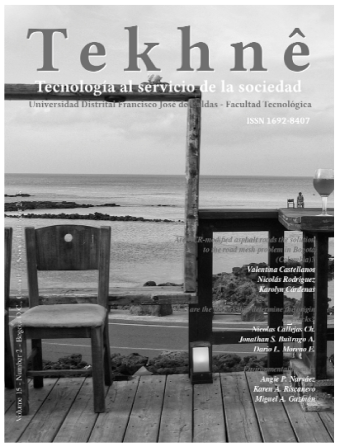
The relation between editors, publishers and owners will be subject to the principle of editorial independence. **Tekhnê** will ensure that articles are published based on their quality and suitability for readers, and not for an economic or political gain. In this sense, the fact that the journal is not governed by economic interests, and defends the ideal of universal and free access to knowledge, provides that independence.

Conflict of interest

Tekhnê will establish the necessary mechanisms to avoid or resolve potential conflicts of interest between authors, reviewers and/or the editorial board itself.

Complaints/allegations

Any author, reader, reviewer or editor may refer their complaints to the competent authorities.



Volume 15 - Number 2 - 2018
ISSN 1692-8407

Index

Declaración de ética y buenas prácticas 6

Code of ethics and good practice 8

Editorial 11

Articles

— Mathematical modeling of a DC motor with separate excitation 13-22
Carlos A. Reyes G.
Gustavo S. Gerena T.

— Modeling and design of DC/DC converters 23-38
Lucas Hincapié C.
Edwin I. Garavito P.

— Civil engineering works, a fundamental basis for social change 39-44
Camila A. Ramirez D.
Lizeth D. Güiza B.
Jesús D. Echeverría G.

— What technologies are being applied in La Guajira (Colombia) for the collection and distribution of water? 45-58
Camilo A. Castillo V.
Lina M. González R.

— Informatics Security - VPN 59-68
Paola A. Segura
Maritza Ramírez F.

Instrucciones para los autores 69

Instructions for author 71

Editorial

La ubicuidad digital se ha convertido en una característica común para la actual generación. Nuestros jóvenes poseen en sus manos dispositivos inteligentes con grandes capacidades de procesamiento, almacenamiento y comunicación que les permite no solo interacción en tiempo real sino acceso continuo a información y recursos. Esta nueva realidad fortalece herramientas de formación ya existentes, como las plataformas de aprendizaje, los sistemas de gestión de cursos, los repositorios, o los MOOCs (Massive Open Online Courses) tan de moda hoy en muchas prestigiosas universidades a nivel mundial. A la vista de estas nuevas posibilidades, las universidades con esquemas de formación tradicional han comenzado a apostar por ellas integrándolas a sus esquemas de formación. Esto sin duda ha permitido aumentar los niveles de cubrimiento y calidad de los programas, pero comienza a despertar inquietudes relacionadas con otros aspectos, tales como el acceso tecnológico en algunos contextos, y el dejar de lado elementos como el aprendizaje crítico y la interacción social de los individuos.

Estos ambientes de aprendizaje soportados en la tecnología crean condiciones y oportunidades únicas en relación con esquemas de aprendizaje personalizado, estrategias de aprendizaje enriquecidas, mayor enfoque y nivel motivacional debido a elementos interactivos y/o audiovisuales. Además, fomenta en los docentes el desarrollo de material y contenido interactivo, particularmente sobre internet. En teoría esto facilita el acceso al material a estudiantes en regiones alejadas o de bajos recursos, pero parte del supuesto de que estos estudiantes tienen acceso a las herramientas tecnológicas necesarias, lo que en muchos casos es incorrecto. Además, un proceso de formación integral debe incluir el sentido crítico, la discusión, la comunicación y el trabajo integrado entre estudiantes, elementos que son débiles en estas nuevas herramientas. Es cuestionable, por tanto, el uso generalizado de estas plataformas de forma aislada, sin contemplar las ventajas del esquema de formación tradicional presencial de la enseñanza.

Ph.D Prof. Fredy H. Martínez S.
Docente Facultad Tecnológica
Universidad Distrital Francisco José de Caldas

Editorial

Digital ubiquity has become a common feature for today's generation. Our young people have in their hands intelligent devices with great processing, storage, and communication capabilities that allow them not only real-time interaction but also continuous access to information and resources. This new reality strengthens already existing training tools, such as learning platforms, course management systems, repositories, or MOOCs (Massive Open Online Courses) so fashionable today in many prestigious universities worldwide. Because of these new possibilities, universities with traditional training schemes have begun to bet on them by integrating them into their training schemes. This has undoubtedly increased the levels of coverage and quality of the programs, but it is beginning to raise concerns related to other aspects, such as technological access in some contexts, and leaving aside elements such as critical learning and social interaction of individuals.

These technology-supported learning environments create unique conditions and opportunities for personalized learning schemes, enriched learning strategies, and increased focus and motivational levels due to interactive and/or audio-visual elements. Besides, it encourages teachers to develop interactive material and content, particularly on the Internet. In theory, this facilitates access to material for students in remote or low-income regions, but it assumes that these students have access to the necessary technological tools, which in many cases is incorrect. Furthermore, a comprehensive training process must include critical thinking, discussion, communication, and integrated work among students, elements that are weak in these new tools. It is questionable, therefore, the widespread use of these platforms in isolation, without considering the advantages of the traditional face-to-face training scheme of teaching.

Ph.D Prof. Fredy H. Martínez S.
Professor at the Facultad Tecnológica
Universidad Distrital Francisco José de Caldas

Tekhnê
July - December 2018, Vol. 15, No. 2, pp. 13 – 22

ISSN 1692-8407

What are the factors that determine the origin of cracks?

¿Cuáles son los factores que inciden en el origen de las grietas?

Nicolas Callejas Ch.
Universidad Distrital Francisco José de Caldas
ncallejasc@correo.udistrital.edu.co

Jonathan S. Buitrago A.
Universidad Distrital Francisco José de Caldas
josbuitragoa@correo.udistrital.edu.co

Dario L. Moreno E.
Universidad Distrital Francisco José de Caldas
dlmorenoe@correo.udistrital.edu.co

This article deals with the problem of cracks, their meaning, characteristics, differences, and similarities with fissures are made known. Having clarity in the above, it begins by identifying the place and structures where the cracks appear, as is done the evaluation and measurement, and with this last one speaks of their importance. The origin of the cracks is influenced by several factors, including physical and external factors, which allow the analysis of the origin of the crack. Finally, the consequences and the methods used to minimize the appearance of cracks are evaluated in order to provide guidance on their effects and possible solutions.

Keywords: Cracks, factors, fissures, measurement, structures

Este artículo aborda el problema de las grietas, se da a conocer su significado, características, diferencias y similitudes con las fisuras. Teniendo claridad en lo anterior, se empieza por identificar el lugar y las estructuras donde aparecen las grietas, como se realiza la evaluación y medición, y con esto último se habla de su importancia. En el origen de las grietas inciden varios factores, dentro de los cuales se encuentran factores físicos y externos, los cuales permiten el análisis del origen de la grieta. Por último, se evalúan las consecuencias y los métodos que se usan para minimizar el surgimiento de las grietas a fin de orientar sobre sus efectos y posibles soluciones.

Palabras clave: Estructuras, factores, fisuras, grietas, medición

Article typology: Research

Date manuscript received: December 7, 2017
Date manuscript acceptance: December 15, 2017

Research funded by: Universidad Distrital Francisco José de Caldas (Colombia).

How to cite: Callejas, N., Buitrago, J., Moreno, D. (2018). *What are the factors that determine the origin of cracks?*. Tekhnê, 15(2), 13 -22.

Introduction

This article gives to know the different causes by which cracks can originate in the constructions, considering the external or physical factors that affect, which are the most common. In the same way, it is shown how to identify them, either by their dangerousness, their size, and the point where they are, among others (Xingwu et al., 2016).

A possible solution to minimize these phenomena is also presented (Khaliq & Basit, 2016). It also talks about the consequences that are caused when there is no adequate control over these pathologies.

Knowing about these structural problems has gained much interest in recent years due to the large collapses and damage that have occurred in buildings by this situation. It is observed that a large part of the problem lies in misinformation and mismanagement of construction methods.

The cracks

Among the different damages that are presented in the buildings, there is one in particular called crack. It is a problem that affects many of the houses in Bogotá (Colombia) and of which people know very little and has much greater importance due to its size.

What is a crack?

In the field of civil engineering a crack *is a deep opening with a width greater than 1 mm* (Construmática, 2017) that emerges uncontrollably in the sections of a structure affecting the building material, tend to divide the building element in two, which weakens the strength of the building causing structural damage (refer to damage generated within the building).

Usually, these types of openings go through the entire section when they originate inside and out, making them even more dangerous.

The main and most important places where these openings can be produced are in the pillars (columns), beams, walls, in the different plates, among others. These places are crucial for the building to maintain its shape, strength, and stability.

Cracks can be sorted by width and can have different degrees of hazard, among which are mild, moderate and severe.

Mild grade cracks or also called fissures *are those in which their width is less than 5 mm, and have a zigzag or diagonal appearance* (Navarrete, 2016). In general, these fissures do not represent a danger to the construction.

Moderate grade cracks *are those in which their width is 5 mm to 1 cm* (Navarrete, 2016), can be expanded longitudinally until they become elongated. Depending on their location they may or may not represent a danger to the building (Fig. 1).

Figure 1. Crack in the house (Gonzalez, 2017).

Severe grade cracks *are those in which their width exceeds 1cm. These cracks represent a great danger to people and therefore their presence requires the evacuation of houses. They are characterized because they expose the materials and are very large* (Navarrete, 2016). This kind of openings leaves the structure with a great instability so that at any moment it can collapse causing great disasters (Fig. 2).

Figure 2. Earthquake-induced cracks (WebAdictos, 2017).

When defining the cause that gave rise to the crack, care must be taken due to the confusion that can occur between fissure and crack. This is to prevent misunderstandings when solving the damage or giving information.

What's the difference between fissure and crack?

In principle, an opening is a space that is generated within a construction element (walls, columns, plates, etc.). According to the Encyclopaedia Broto of pathologies in construction (Broto, 2006), a fissure is an opening that appears on the surface of a building element and is less than 1 mm wide.

Also *Cracks can be a stage prior to the appearance of a crack, they also have similarities in terms of the symptoms they suffer, but they lead to a different origin and evolution* (Broto, 2006). This suggests the relationship between fissure

ISSN 1692-8407

and crack. Fissures are one of the symptoms of concrete pathology (Silva, 2016).

Charles Broto (Broto, 2006) proposes the subdivision of fissures into two groups:

- **Reflection of the support**: It is produced when there is a constructive discontinuity by a joint (the space where *the glue* is poured between the bricks, Fig. 3).

Figure 3. Crack in concrete wall (Arbsuwan, 2017).

- **Inherent to the finish**: In this case, it is spoken superficially that the fissure in this group is formed by retraction in the mortar (Fig. 4).

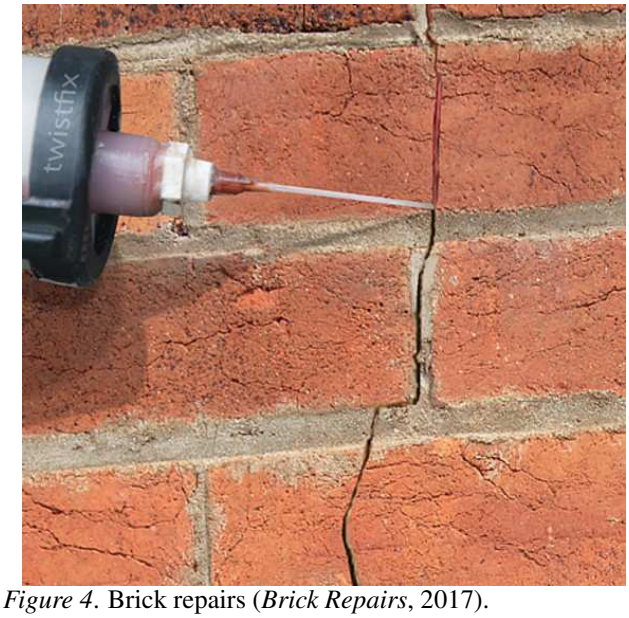


Figure 4. Brick repairs (*Brick Repairs*, 2017).

With the previously mentioned, the difference between fissure and crack can be described in a group of characteristics which are: width, origin (the reflection of the support or inherent to the finish) and evolution (Fig. 5).

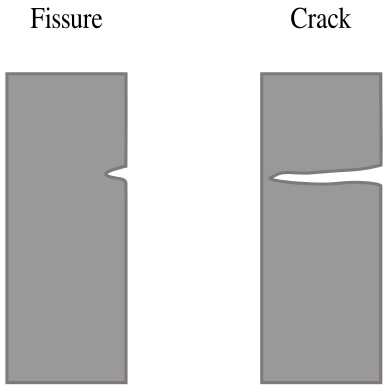


Figure 5. Fissure and crack comparison.

Places where cracks appear

Cracks usually appear in all housing. The places where these appear are associated to a specific zone, which is commonly located in the walls. People can all see some kind of crack or fissure in homes, but there is always a tendency to associate cracks with a wall. However, the walls are not the only places where these pathologies appear, so below are described the places where it is possible to appreciate the appearance of a crack.

- **Cracks in the walls**: They are the most common, originated in the cladding of the wall and extended to reach a very significant length, so much so that it can cause irreparable damage to the construction.

When the wall is without a cladding, the brick or block and the mortar are exposed, which due to certain environmental factors cause the appearance of cracks and fissures. This allows us to see that the bricks or blocks and mortar are not exempt from the presence of cracks, giving them the ability to accommodate this problem (Fig. 6).

Figure 6. Cracks in the wall (Ayala, 2017).

• **Cracks in tiles, veneers or tiles**: When openings occur in these types of construction elements they tend to be fissures because of their width. In spite of this, they can have a great extension. They are common, but not very noticeable.

Cracks may be present in the joints of the above elements. It is very rare, and the majority of the cases that arise are due to improper use of the additive element (Fig. 7).

Figure 7. Wall tiling (Baldwin, 2017).

• **Cracks in columns, beams**: As they are constructive elements that can be made of both concrete and wood, we will focus only on those that are made of concrete.

Like walls, columns and beams tend to present cracks, caused by different factors that we will mention in the next section. They can cause great disasters because they are the support of the structure in the case of porches and combined systems (Fig. 8).

Figure 8. The PSOE denounces that the columns of the laundry have cracks (Arteixo, 2014).

Assessment and measurement

As mentioned earlier, cracks are very common manifestations in structures that are easy to recognize. In order to identify them, the place where they appear, the direction and the size of the crack are examined.

The cracks have a development time and it is necessary that from the moment in which the crack was observed a follow up is made to the crack, a measurement of its length and width, and of its layout.

Initially, an analysis of the structure must be carried out: pathologies, settlements, characteristics of the land, old uses of the land, etc. Also, make a detailed description of the fissure or crack with the help of some elements that will facilitate its analysis.

• **Fissure meter**. It is an element that allows measuring the thickness of the fissure (Fig. 9).

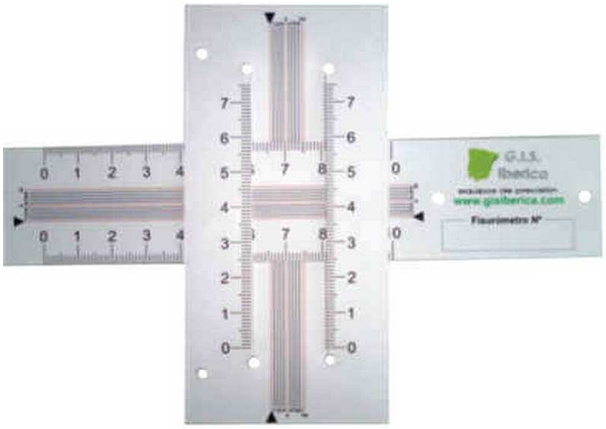


Figure 9. Fisurometer (GIS Iberica, 2017).

• **Witnesses of plaster or glass**. They allow us to observe the evolution and life of cracks and fissures, to know if they are still active or to place them preventively and to know the development of the crack, to know if its evolution is slow, fast or not progressing (Fig. 10).

Figure 10. Stucco witnesses (Pagina, 2017).

• **Thread deformometers**. They allow monitoring the changes between the distance of two points. Generally used in the measurement of small cracks (Fig. 11).

With the help of the elements mentioned above, it is possible to know the thickness, direction of the crack, and make comparisons at different dates, which helps to determine in which direction the forces that cause the appearance of this pathology are being performed to analyze

ISSN 1692-8407

Figure 11. Thread deformometers (Sisgeo, 2017).

them and see the possible causes. They should also be taken to a general plan of the structure to have a better overview of its behavior.

Crack data should be evaluated with the help of measurements of turns, inclinations, and collapses. To make these measurements are used devices such as dianas, optical plummets, level staff, precision photographic levels, inclinometers, among others.

Thanks to these methods, it is able to address possible problems with the structure, classify the crack and its evolution, in order to obtain a solution and/or evaluate the risk it causes in the structure.

Importance of knowing about cracks

Cracks in recent years have taken a very significant role in assessing the state of a building, because if they are present means that something harmful is happening in the structure, although not all mean a risk to the construction.

This is why it is important to have knowledge about cracks because this allows us to identify how dangerous they can be and also the steps to follow from the moment they appear. But not only to know how dangerous they are but also to anticipate in advance that they may arise.

Crack generating factors

Physical factors

The physical factors that influence the generation of cracks and affect the structures are the following:

- Humidity expansion.
- Dilation.
- Retraction.

Humidity expansion. This problem mainly affects ceramic materials (vaults, bricks, and other ceramic pieces) as they have an inverse characteristic to the one in concrete. Concrete starts humid and loses this humidity, whereas ceramics start dry because its elaboration process is carried out in ovens at a high temperature, and its humidity generates a balance with the humidity of the environment.

It is a phenomenon in which the ceramic expands while it gains humidity *in the first month can expand half of the total, in the first week half of all of the month, and on the first day, half of all of that week. Ten years later, it still has something to expand* (De Miguel, 2017a). However, this process can be accelerated if moisture is initially captured by irrigation or immersion to avoid major consequences on the structure. As a reference, we have expansion in the ceramic in the order of 0.5 mm/m if the irrigation has not been done before the assembly.

If the brick or ceramic is potentially expansive and has not been watered enough, it begins to slowly increase in size, until it becomes trapped in the building elements because it cannot expand further, and to increase its tension causing the bursting of the same, throwing pieces and with the ability to cause personal injury.

The most characteristic fissure of this problem is the vertical fissure near the edges as shown in Fig. 12.

Figure 12. Dilatation by humidity (De Miguel, 2017a).

Dilatation. All physical bodies in the face of a variation in temperature change their size. If the temperature increases the physical body increases its size if the temperature decreases the body shrinks. The same happens with structures, if the building increases its temperature, its dimensions would also increase (Fig. 13).

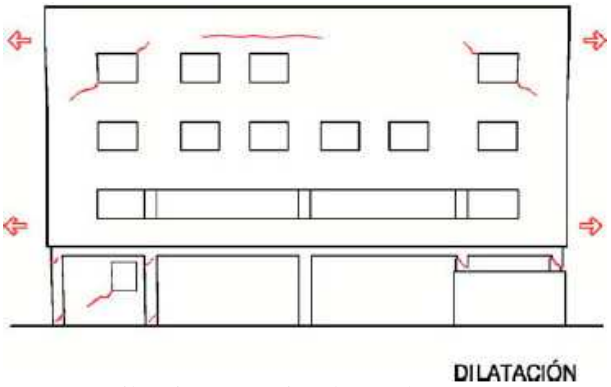


Figure 13. Dilatation (De Miguel, 2017b).

As a reference value, we have 0.01mm/m for each ^{o}C increase. To understand it better we have the following example: *an element of 25 m long that oscillated its temperature from winter to summer, in sunny front, in 80^{o}C, would increase its length in 2 cm, displacing each one of its ends 1 cm towards outside* (De Miguel, 2017b).

As the length increases and the building does not have the capacity to resist such effects, the supports of the construction are curved and this generates maximum flexions at its ends and a zero flexion in the middle, thus generating cracks in the structure.

To be able to identify if the cracks were caused by thermal action we look at the part where the cracks appear, the most usual is that they appear at the ends as they are weakened by the openings of the structure. If the supports are made of concrete, diagonal cracks appear above and below as shown in the lower left part of Fig. 13.

Retraction. Retraction consists of the loss of water suffered by the concrete in its drying process, generating a balance between humidity and air, causing the volume of the concrete to decrease. As a reference we have *0.1 mm/m after seven days, 0.3 mm/m in a year. For example, an element 30 m long would shorten in one year, about 1 cm* (De Miguel, 2017b) (Fig. 14).

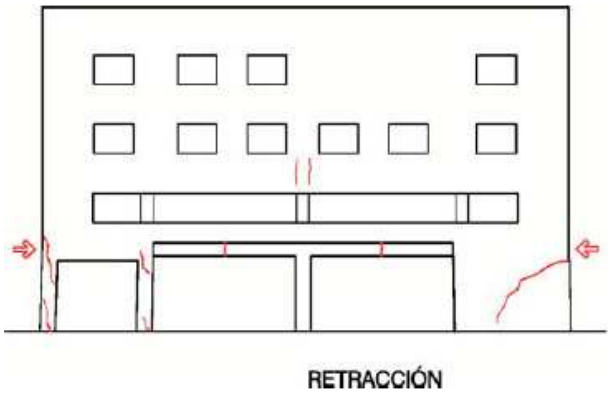


Figure 14. Retraction (De Miguel, 2017c).

When there is pressure, the concrete is the one that fractures, where it does not necessarily involve the rest of the construction elements. However, it is structural damage and should be cataloged as self-injury.

The crack is generated similar to dilatation, where flexions are generated in the supports, which causes it to bend and form cracks as shown in Fig. 14.

The appearance of cracks by retraction occurs mostly in the lintels, since when this tries to reduce its length and fails to move the elements that support it, it generates resistance and therefore traction, causing the appearance of cracks in that segment. The same happens in other parts of the structure, as in the supports, but it is more usual in the lintels.

External factors

Among the external factors we have: differential settlement, expansiveness, horizontal action, deflection, overloads, fires, construction clumsiness.

Differential settlement. The land where the buildings are built undergoes different changes depending on the factors that affect it. One of the factors is the loads generated by the construction itself. These loads cause sinking in the ground and therefore the footings (López, Guaita, Ayuga, & Cañas, 2000), but can occur in different parts of the building, and this is what is called differential settlement (Fig. 15).

Figure 15. Footing settlement (De Miguel, 2017d).

The damage caused by the settlements are the cracks, usually these cracks are inclined and directed to the point where is the settlement, have an arc shape and appear at all levels of the construction.

Expansiveness. This effect occurs when buildings are located on clay soil. The clay manifests certain humidity and when it increases, due to the filtration of the water in the ground, it increases its volume producing a push upwards of the footings (Fig. 16).

Figure 16. Terrain expansiveness (De Miguel, 2017e).

Due to the expansiveness, local cracks originate and can be more vertical. They are more difficult to control as they can start from the supports (columns and beams). In some cases, the expansion is so great that it does not generate a push but breaks the foundation.

Horizontal action. When we speak of horizontal action we refer to the seismic movement of the soil. As we know these movements can come in any direction, and their

ISSN 1692-8407

duration is not much but produces significant disasters. They can also cause cracking in buildings that can be mild or severe (Fig. 17).

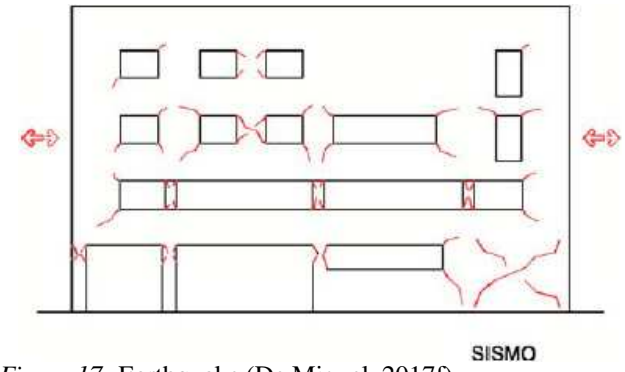


Figure 17. Earthquake (De Miguel, 2017f).

The slight cracking is when the telluric movement is minimal, and small cracks are originated more than everything around the spans and not very significant.

On the other hand, we have severe cracking, which is given in the form of a cross. It is usually between the supports and the walls and has an extensive length. This type of cracking is very significant as it weakens the building to a point of collapse. They generally occur in the weakest points of the building.

Deflection. When we speak of the deflection factor we are referring to the punctual and distributed loads of the building. The different constructive elements are influenced by the loads causing them to suffer a flexion and therefore a deformation. This occurs when the capacity to support the weight of the building itself and everything in it is exceeded (Fig. 18).

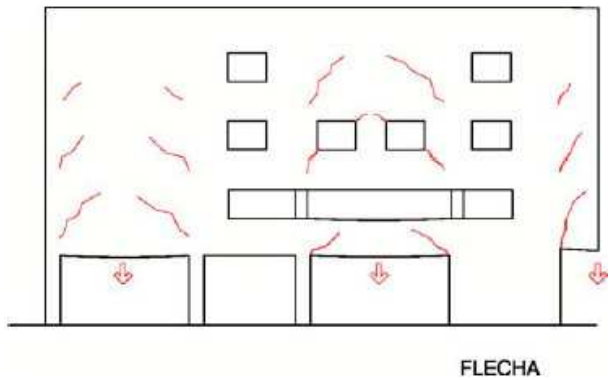


Figure 18. Deflection (De Miguel, 2017g).

The deflection produces an aggregation that is given from top to bottom. To identify if the building suffers this situation must be tested before it is inhabited, placing loads in strategic locations and verifying that it can withstand them without flexion in the columns, beams, and plates.

Construction clumsiness. When constructing a building there can be several errors which can cause cracking. These errors can be of calculations, plans, or work among others. Although they do not occur very frequently, it can occur either because of the strength or efficiency with which the building materials are handled.

Cracks caused by construction errors can be seen in the joining and bonding of the materials, for example in the mortar between the blocks (Fig. 19).

Figure 19. Basement kits carbon wall repair fiber (Code, 2017).

Vibrations. Other agents that cause the appearance of cracks in the constructions are vibrations. These are produced either because around the building there is the passage of heavy vehicles or because they are being made buildings in neighboring areas.

Cracks caused by vibrations do not represent a significant risk, they can be treated as aesthetic damage. Although if they occur in strategic points such as pillars or those elements that are of support, they can be of great danger.

Consequences, minimization and reparation of cracks

Consequences of cracks

Cracks cause significant damage to structures. In spite of the underestimation they are given, they have a considerable impact in the field of construction. For that reason analyzing the consequences that can generate provides valuable information and preventive at the same time.

Whether it's construction settlement, imperfections in the materials used to build the home, or damage caused by the environment, cracks can become a big problem.

As for housing in Colombia, there are cases in which government-supplied housing has cracks causing severe damage to construction, as can be seen in cases such as Metrovivienda in Cúcuta (Colombia) in 2015, where people living in nearly 80 apartments in the urbanization had to go through the fear that their homes would collapse. In terms of repairs, the construction company carried out repairs on four occasions, but cracks were still appearing (Tiempo, 2015a).

There are also cases of cracks caused by adjacent construction. In 2013 began the construction of a work in the locality of Usaquén (Bogotá, Colombia), in which the excavations generated cracks in the houses surrounding the work. In addition, the damage caused by this construction went so far as to issue eviction notices for the serious damage caused (Tiempo, 2015b).

Returning to social housing, some of these located in San Luis, Ciudadela Parque de la Roca and El Trigal, La Aguadita in Suba, Villa de Los Alpes de San Cristóbal, the apartments of these houses collapsed after three years. The main signs show that it was due to cracks in the structures, the window sills, the walls, and the roof. More than a thousand families were affected by the cracking and collapse of their homes (Gómez, 2000).

In the case of earthquakes, there are documented cases that show how they cause cracks and thus bring their consequences. Internationally we can speak of Tanaguarenas (Venezuela), where the cracks that Misión Vivienda had were enlarged by an earthquake of magnitude 4.5 in which the inhabitants expressed fear that the structure would collapse (Nacional, 2017).

From the previous cases, it can be seen that cracks are a matter of care. They can lead to many tragedies, and their identification and management can prevent them. Facing the cracks and taking precautions is something that we must all do no matter how unnecessary it sometimes seems so that the cases mentioned above do not happen.

How can the appearance of cracks in a home be minimized?

There are many ways to prevent the manifestation of cracks, but the method used depends on what type it is and what causes it. The most common ways in which this type of pathology can be reduced are the following:

Gaskets. This method is to be used to avoid contraction and retraction cracks, either caused by humidity or temperature changes. It will help the construction element to have a slight movement so as not to have a collision with another element, *It should not exceed 30 times its thickness, the ideal would be between 25 cm and 40 cm thick* (Grados, 2017).

Use of construction norms. In many of the cases in which cracks are present, it is because construction masters (mostly in low socioeconomic strata) do not adequately follow the building rules, and omit steps that are necessary to minimize the emergence of these. This situation can be corrected by making known the rules governing the construction of buildings and making proper use of them.

It is possible to add, in addition, the horizontal action, that is to say, to include also the cracks that arise by the horizontal action which can be minimized with exact handling of the norm NSR-10 (Colombian Earthquake Resistant Norm of the year 2010).

Adequate study of soils. Another of the great factors originating in the cracks is the type of soil in which the buildings are built since if a soil study is not carried out in which it is evident with which it is treated, differential seats, expansive terrain and deflection can be presented.

To avoid this it is possible:

- The main thing is to carry out the study of soils.
- If this study cannot be done, the procedure to follow is to start digging and look at the level at which the most stable soil can be found.
- Also where the footing is going to be made, with a type of mass (rammer) the soil can be compacted to give greater stability, and that these footing does not suffer a downward displacement.

Quality and proper use of materials. When speaking of the proper use of materials, it refers to the fact that when mixing and everything related to the preparation of materials to start building, the established proportions must be managed. An example, in this case, is the preparation of the concrete. The concrete should not be too watery (it should not have a large amount of water), only the amount of water necessary to obtain the greatest resistance.

The quality will be related to the fact that the materials are not fractured, do not present a deterioration and their expiration date is not expired.

How can the cracks be repaired?

Even with precise handling and compliance with all parameters, there may be a case of cracks in the building.

Therefore, the following parameters must be taken into account:

- What surface is it located on? This refers to whether the location is on concrete, wood, brick, etc.
- Where it is located. That is to say, it is in the roof, the wall, the floor, among others.
- What kind of crack is it? In this parameter, it is established how dangerous it is, its thickness, its location, and its depth.

It is clear that if it is already very dangerous, it should not be handled so easily. It is necessary to have the opinion of an expert to know the steps to follow.

Techniques to repair cracks.

- **Resin injection**. The procedure is very simple, as its name indicates, is to inject a type of glue called resin which has fast drying properties and is used in small cracks.
- **Crack cover putty**. The mixture is obtained by combining white cement with water. It should be free of lumps and is applied by filling the space of the opening.
- In the market it is possible to obtain very easily adhesives for this type of pathologies, they are very varied and do not present complexity at the time of using them.

ISSN 1692-8407

- For larger cracks can be used bands cover cracks. At the moment of using them, plaster is needed in order to have a better fixation.
- Depending on the type of material the necessary products can be found. For example, in bricks and cement, putties are used, and anticorrosive products are used if any steel material is exposed.
- Finally, even simpler, only the use of paint is necessary to be able to cover them.

Conclusions

Crack research provides more detailed and complete information on behavior, occurrence, factors, evaluation, repair, and how to minimize the problem of cracks. This must be within the reach of the whole society in order to achieve a basic level of knowledge about this problem since it is a structural problem that depending on its size and shape can generate great damage and usually affect homes and/or structures.

There are several types of cracks and fissures that must be differentiated to achieve an optimal evaluation of each of them. The evaluation is carried out with the use of some methods and devices, all with great utility and ease of use. The best known and used are the fissure meter and the plaster or crystal witnesses. Each of them helps to identify the direction, size, and activity of the crack.

The appearance of cracks can be observed in all construction systems of the structure without exception. These systems can be affected by factors external to the structure (earthquakes and overloads, among others), or physical factors (humidity, retraction, and dilatation), causing cracking and deterioration of the structure.

Nowadays, in most of the constructions that exist both on the slopes and in some vulnerable and humble areas of Bogotá (Colombia), it can be observed that the population does not carry out soil studies, either because of ignorance or because they do not have the money to do so. This is a very important factor that generates the appearance of cracks when not taken into account. The study of soils is a requirement according to the Colombian Earthquake Resistant Norm, for that reason all structure either of a floor, two or more must be evaluated and constructed on the basis of the norm. This would help that a great number of structures be safer and resistant, and additionally, they are structurally strong in front of an earthquake or external factors to itself.

In order to minimize cracks, the Colombian Earthquake Resistant Norm must be taken into account, which is the basis of all construction and allows for the construction of a structure that adjusts to the terrain and takes into account any factor that may generate cracks.

If some of the suggestions for minimizing cracks are not taken into account, and a crack is generated, it must begin to analyze which repair technique is most appropriate so that the structure is not greatly affected.

Additionally, it could be analyzed and investigated in the future that other solutions, tools, and methods can be taken into account to evaluate and minimize the appearance of cracks and their repair.

References

Arbsuwan, T. (2017). *Crack in concrete wall.* Retrieved from https://www.123rf.com/photo_18968665_crack-in-concrete-wall.html

Arteixo, R. (2014). *El psoe advierte del peligro de que se desplome parte de la estructura del lavadero municipal de oseiro.* On line. Retrieved from https://www.elidealgallego.com/articulo/area-metropolitana/arteixo-el-psoe-advierte-peligro-desplome-/parte-estructura-lavadero-municipal-oseiro/20140415232513183890.html

Ayala, E. (2017). *Cracks in the wall.* Retrieved from https://i2.wp.com/suracapulco.mx/wptest/wp-content/uploads/2017/09/cc-cuarteadura-escuela-playa-de-Ayala-sismo.jpg?fit=3000%2C2000

Baldwin, W. (2017). *Alicatar pared.* On line. Retrieved from http://wallanbaldwin.com/alicatar-pared.html

Brick repairs. (2017). On line. Retrieved from https://ledscs.com/brick-repairs.html

Broto, C. (2006). *Enciclopedia broto de patologías de la construcción*. Links International.

Code, C. (2017). *Basement kits carbon wall repair fiber.* On line. Retrieved from https://cellcode.us/quotes/basement-kits-carbon-wall-repair-fiber.html

Construmática, P. (2017). *Grietas.* On line. Retrieved from http://www.construmatica.com/construpedia/Grietas

De Miguel, J. (2017a). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina10.asp

De Miguel, J. (2017b). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina5.asp

De Miguel, J. (2017c). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina6.asp

De Miguel, J. (2017d). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.

asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina3.asp

De Miguel, J. (2017e). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina4.asp

De Miguel, J. (2017f). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina7.asp

De Miguel, J. (2017g). *El lenguaje de las fisuras y grietas, y su diagnosis.* On line. Retrieved from https://www.asemas.es/portal/web/articulos/informe_fisuras_grietas/pagina8.asp

GIS Iberica. (2017). *Fisurometros.* On line. Retrieved from www.gisiberica.com

Gómez, L. (2000). *Grietas en la vivienda social.* On line. Retrieved from www.eltiempo.com/archivo/documento/MAM-1265742

Gonzalez, R. (2017). *Tengo una grieta en casa: En qué casos me debo preocupar.* On line. Retrieved from https://www.valenciabienesraices.es/index.php/blog/item/95-tengo-una-grieta-en-casa-en-que-casos-/me-debo-preocupar

Grados, C. (2017). *Tipos de juntas en muros y pisos de concreto.* On line. Retrieved from http://blog.360gradosenconcreto.com/tipos-de-juntas-en-muros-y-pisos-de/-concreto/

Khaliq, W., & Basit, M. (2016). Crack healing in concrete using various bio influenced self-healing techniques. *Construction and Building Materials*, *102*(1), 349-357.

López, M., Guaita, M., Ayuga, F., & Cañas, I. (2000). Asientos en zapatas corridas. comparación entre teorías clásicas y el método de los elementos finitos. *Informes de la Construcción*, *52*(467), 5-14.

Nacional, E. (2017). *Sismo causó grietas en edificio de misión vivienda en vargas.* On line. Retrieved from http://www.el-nacional.com/noticias/sociedad/sismo-causo-grietas-edificio-mision-vivienda/-vargas_201264

Navarrete, G. (2016). *Aprende a identificar si es una grieta o fisura.* On line. Retrieved from http://www.metroscubicos.com/articulo/decoracion-y-hogar/2016/04/21/como-identificar-si-es-grieta-o-fisura

Pagina, S. (2017). *Testigos de yeso.* On line. Retrieved from http://pagina66.com/upload/img/periodico/img_19931.jpg

Silva, O. (2016). *¿qué es la patología del concreto?* On line. Retrieved from https://www.360enconcreto.com/blog/detalle/la-patologia-del-concreto

Sisgeo, S. (2017). *Deformimetros de hilo.* On line. Retrieved from https://www.sisgeo.com/es/productos/deformimetros-fisurometros-y-medidores-de-/juntas/item/deformimetros-de-hilo.html

Tiempo, E. (2015a). *Denuncian grietas en viviendas dadas por el gobierno en cúcuta.* On line. Retrieved from http://www.eltiempo.com/archivo/documento/CMS-15558918

Tiempo, E. (2015b). *Obra en usaquén causó grietas en casas vecinas.* On line. Retrieved from http://www.eltiempo.com/archivo/documento/CMS-15361601

WebAdictos, S. (2017). *¿cómo analizar las grietas provocadas por sismos?* On line. Retrieved from https://webadictos.com/grietas-provocadas-por-sismos/

Xingwu, Z., Gao, R., Ruqiang, Y., Xuefeng, C., Chuang, S., & Zhibo, Y. (2016). Multivariable wavelet finite element-based vibration model for quantitative crack identification by using particle swarm optimization. *Journal of Sound and Vibration*, *375*(4), 200-216.

Tekhnê
July - December 2018, Vol. 15, No. 2, pp. 23 – 38

ISSN 1692-8407

Environmental licenses

Licencias ambientales

Angie P. Narváez
Universidad Distrital Francisco José de Caldas
paoola._1529@hotmail.com

Karen A. Riscanevo
Universidad Distrital Francisco José de Caldas
adriana.09_17@hotmail.com

Miguel A. Guzmán
Universidad Distrital Francisco José de Caldas
migue.guzman25@hotmail.com

This article is intended to provide an information tool for obtaining an environmental license, which is based on Decree 2041 of 2014 on environmental licenses, which provides the instructions, entities, and information necessary to carry out the procedures of the licenses. Likewise, the information provided by the environmental authority ANLA (National Authority of Environmental Licenses) is used, since it is fundamental for the drafting of this article. This document is informative and does not pretend to give legal advice, therefore, the people who make use of it will not have any claim for expenses or commitments acquired with the information provided.

Keywords: ANLA, environmental impact, environmental license, management plan, UPME

En este artículo se pretende brindar una herramienta informativa para la obtención de una licencia ambiental, la cual se basa en el decreto 2041 de 2014 sobre licencias ambientales, el cual brinda las instrucciones, entidades e información necesaria para realizar los trámites de las licencias. Igualmente, se hace uso de la información que brinda la autoridad ambiental ANLA (Autoridad Nacional de Licencias Ambientales), ya que es fundamental para la redacción del presente artículo. Este documento es de carácter informativo y no pretende otorgar asesoría legal, por lo cual, las personas que hagan uso de este no tendrán reclamo por gastos o compromisos que se adquiera con la información que se brinda.

Palabras clave: ANLA, impacto ambiental, licencia ambiental, plan de manejo, UPME

Article typology: Research

Date manuscript received: December 7, 2017
Date manuscript acceptance: April 13, 2018

Research funded by: Universidad Distrital Francisco José de Caldas (Colombia).

How to cite: Narváez, A., Riscanevo, K., Guzmán, M. (2018). *Environmental licenses*. Tekhnê, 15(2), 23 -38.

Introduction

This document provides a guide to the process of obtaining an environmental license, covering the fundamental issues that a person or entity interested in the license needs to know, such as the Environmental Authorities, the problems that can arise in the process, the steps to follow, relevant information and the documents required by the Environmental Authority (Balaguera et al., 2017; Pagiola, Honey, & Freire, 2016; Zarate & Maldonado, 2015).

At first, we will talk about the definition of a license, as the need arises to control the environmental impact of works that exert some change in nature, in addition to this, it will show the changes that have had this rule given the factors that affect compliance with it, mention the functions of ANLA, CAR (Regional Autonomous Corporations), UPME (Mining and Energy Planning Unit) which are entities responsible for carrying out the entire process for obtaining these licenses and also make the appropriate sanctions for those who comply with the licenses (Boron et al., 2016; De Pourcq et al., 2015; Delgado et al., 2015).

There are three types of licenses, the only one, the ordinal and the global, each one has some parameters that establish up to what point the use, movement or exploitation of the natural resources can be done, on the other hand, it shows the problems that are presented at the time of obtaining a license or are generated after being issued, finally, it gives the information of how to obtain a license since there is a variety of licenses and it shows some parameters that are frequently presented at the time of requesting a license (Ezzine-De-Blas, Wunder, Ruiz, & Del Pilar, 2016).

Definition and history

The environmental licenses are instruments that allow to make an environmental planning to regulate the damage that can make a project in the environmental surroundings, for this reason, the licenses grant authorization through an administrative act for the controlled management of the damage of the works in the environment.

The environmental licenses arise from the seventies in Colombia, when the Code of Renewable Natural Resources and Environmental Protection appeared, and its implementation is given from the expedition of Law 99 of 1993. This code modifies the relationship of man with nature, it showed that nature is important as a common patrimony and they must mitigate the damage that has been caused by the construction of civil works, also, the responsibility that engineers have when they build on land that is not appropriate since it can be located in a wetland or have other important aspects that can affect nature, before this rule, no regulation required them to study the environmental impact of the work they are executing and that there would be greater degradation of the environment (G. Rodríguez, 2017).

It can be seen that over the years different standards have been issued by which environmental licenses have been regulated such as Decree 330 of 2007 by which environmental public hearings are regulated and Decree 2762 of 2005 is repealed, Decree 500 of 2006, by which Decree 1220 of April 21, 2005 is modified, regulating Title VIII of Law 99 of 1993 on environmental licenses, Decree 1220 of 2005 by which Title VIII of Law 99 of 1993 on environmental licenses is regulated, Decree 1753 of 1994 by which Titles VIll and Xll of Law 99 of 1993 on environmental licenses are partially regulated, resolution 655 of 1996 by which the requirements and conditions for the application and obtaining of the Environmental License established by article 132 of the decree Law 2150 of 1995 are established (G. Rodríguez, 2017), in these changes different problems have arisen such as the flexibility of the norm during the different changes it has had and thus making the process for obtaining an environmental license in Colombia easier, neglecting the main function of the license which is to respond to the need for prevention, to mitigate, correct, compensate, manage and control the impacts to the environment generated by human activity, in order to establish the way in which they can be managed in a responsible way with the protection of the environment, The aim is that nature is affected as little as possible in the different processes of civil construction, making different studies of the land and the environment surrounding the work, and also making people aware of the sanction involved in not executing the stipulations of the environmental license, which can be sanctions or even taking away the project's license, but This rule is not completely fulfilled because they allow themselves to be affected by economic benefit or so-called *blackmail* in exchange for giving the licenses in a shorter period of time and to industries such as the oil industry that cause a great environmental impact on the rivers and even so it is the one that has the highest percentage of licenses issued and there is no constant monitoring in this type of work.

To know about environmental licenses it is important to know about Decree 2041 of 2014, which was generated by the president of the republic and regulates Title VIII of Law 99 of 1993, a title referring to environmental licenses (Villalobos, 2016). This is generated by the need for environmental licenses in projects that affect the environment and to strengthen licensing in the search for environmental protection.

To obtain an environmental license there are several competent environmental authorities in charge of issuing this authorization and which vary according to the location of a person, company or corporation interested in a license, some

ISSN 1692-8407

of these environmental authorities exposed in decree 2041 of law 99 of 1993 are (Fig. 1):

- Some municipalities and districts
- The Ministry of Environment and Sustainable Development.
- Regional Autonomous Corporations (CAR).

Figure 1. The Regional Autonomous Corporations in Colombia (CAR) (Invierta en Colombia, 2017).

According to the regulation, the National Government will be in charge of regulating the cases in which the previously exposed environmental authorities can grant the environmental licenses, taking into account that these must have the administrative, operative and economic capacity for the development of this exercise and in which cases it is necessary to present the environmental impact study, as well as the environmental diagnosis of alternatives in a project. The structure is based on three fundamental parts.

Environmental diagnosis of alternatives

Its purpose is to provide the information to evaluate and compare the different options presented by the petitioner, under which it is possible to develop a project, work, or activity (Fig. 2). This diagnosis must take into account the geographical, biotic (life in the environment), abiotic (lifeless objects), and socioeconomic aspects to analyze these factors as a whole (Martínez & Martínez, 2013, 2014). In this way, it will be possible to know the effects that a project will cause in an environment and also generate solutions, mitigation plans, and control of the damages that may be caused, rationalizing the use that is given to the natural resources (Fig. 3).

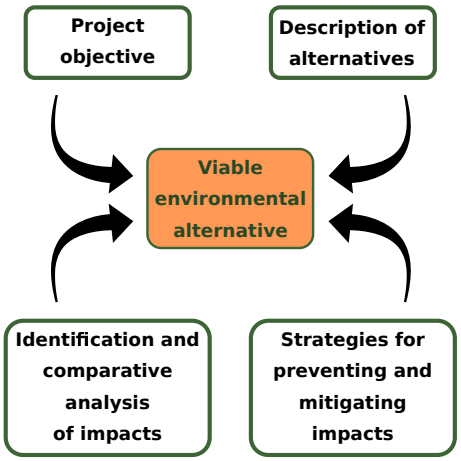


Figure 2. Content of the EDA (Environmental Diagnosis of Alternatives).

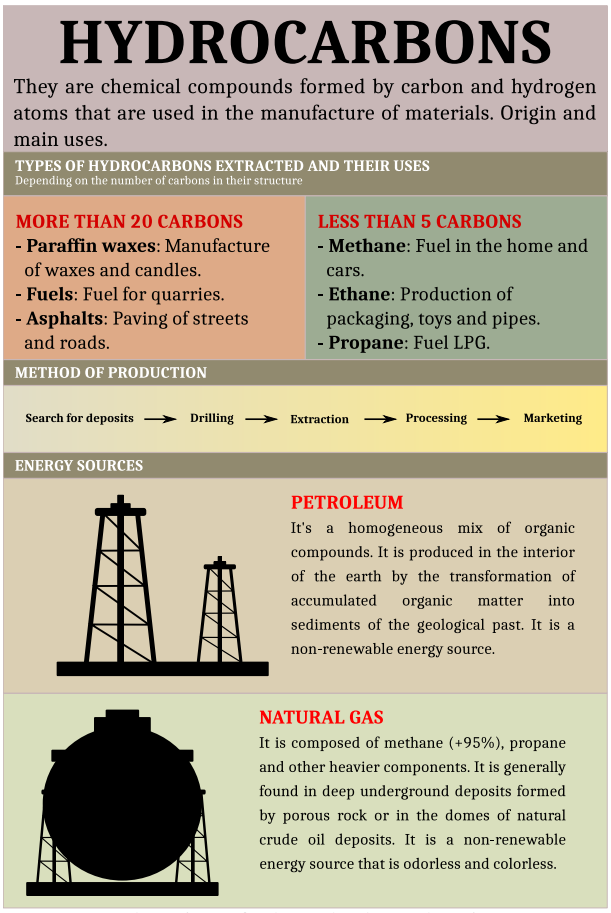


Figure 3. Explanation of what a hydrocarbon is.

The works or activities that need to present an Environmental Diagnosis of Alternatives to the environmental authorities according to decree 2041 are:

• Those projects that require seismic exploration of hydrocarbons and which have the need to build roads for vehicle traffic.

• The transportation of non-renewable resources such as liquid or gaseous hydrocarbons that require the construction of infrastructure of conduction lines equal to or greater than 15.24 cm in diameter, unless the construction of these lines is carried out on formerly established conduction lines and follows their path.

• Hydrocarbon storage infrastructure is associated with pipeline transportation.

• Construction of structures for the reservoir of water for its supply as dams or reservoirs.

• Installation and operation of power generation plants.

• Exploration projects and the use of energy that does not involve the burning of fossil fuels with a capacity greater than 10 kW.

• Transmission of energy in the National Transmission System.

• Management of nuclear energy.

• Construction of facilities dedicated to the transport of goods, people or information, and their safety.

• Installation of airports.

• Construction of roads and associated infrastructure such as tunnels, bridges, etc.

• Construction of roadways.

• Works located in fluvial networks such as rivers, streams, lakes.

• Implementation of railroads and associated with these.

• Works that aim to increase the availability of water for a population by adding the flow of water from nearby basins.

• An Environmental Diagnosis of alternatives must be prepared according to Article 14 of Decree 2041 and must contain

• Objectives and description of the project to be carried out

• Alternatives for the location of the project to be worked on, as well as the alternatives for the effect it has on the social and economic environment.

The implementation of industrial platforms to refine petroleum and plants that make use of petroleum or natural gas in order to develop products derived from them.

• A project's compliance with the use and manner in which the land will be affected will be regulated by the Territorial Management Plan.

• The general analysis of the negative and positive aspects that a project generates in the environment, as well as the risks that it may generate, with their respective alternatives for the management of the affected natural resources.

• Explain the methods for informing the surrounding communities about the project.

• The analysis of the costs and benefits that are exposed to the project.

• The justification for the choice of one of the alternatives that were exposed to carry out the project.

The environmental authority in charge of reviewing this information shall be based on the Manual of Project Studies of Article 16 of Decree 2041 and that the requirements set forth above have been complied with, especially that the corresponding comparisons of environmental impacts have been made according to each alternative presented.

The information from the assessment should be reviewed and evaluated to ensure that it is relevant and sufficient for the selection of the best project alternative and that it presents informed responses to community concerns and observations (Vallejo, 2017).

Environmental impact study

It is the basic instrument for making decisions on projects, works, or activities that require an environmental license and will be required in all cases where an environmental license is required by law. Its objective is to study and evaluate the resources that can be affected by the development of a civil construction project. This must contain the following:

• Inform about the project to be carried out, as well as aspects related to location, infrastructure and present the activities to be implemented.

• Determination of the area that will be affected by the project, as well as, the effects that it will cause in the abiotic, biotic, and socioeconomic means.

• Monitoring plan for the biotic, abiotic, and socioeconomic environments affected by the project.

• The demand for natural resources by the project. The information required for the application of permits related to the capture of surface water, discharges, occupation of watercourses, use of construction materials, forestry, collection of biological diversity specimens for non-commercial purposes, air emissions, solid waste management, exploration and exploitation of groundwater is presented (Vallejo, 2017).

• The report about the estimation of impacts, risks, and details that may generate environmental damage.

• Zoning defined for the project, in which the area to be worked on must be identified, as well as the areas that have restrictions and areas with exclusions.

• The economic valuation of the impacts generated by the work, whether negative or positive,

• The environmental management plan of the project, in which the management program must be informed with its costs to generate the operation and differentiated in projects.

• A contingency program for the preparation and development of the project, which must include risks from spills, fires, leaks, and contamination outside the limits of the permitted area.

ISSN 1692-8407

- A dismantling and abandonment plan that defines the final use of the land, management measures, restoration, and reconfiguration of its characteristics.
- 1% investment plan, which includes the elements and costs to estimate the investment, and the proposal of investment projects, this allows evaluating the financial viability and the impact of the project on the development, being developed as treated in the Decree 1900 of 2006 or the norm that renews it.
- Plan to repair damage caused to biodiversity, this must comply with Resolution 1517 of August 31, 2012, or the one that updates it.

It is important to carry out an anticipated Environmental Impact Study on the areas of interest in the case of hydrocarbon drilling and extraction. An analysis of the environmental sensitivity of the area to be extracted, the corridors of the access roads, production tests, and the transportation of the fluids generated in tank cars and/or pipelines is necessary (Vallejo, 2017).

The Manual for the Evaluation of Environmental Studies of Projects is used to evaluate the Environmental Impact Study, this is responsible for observing that the criteria set out in Articles 14 and 21 of Decree 2041 are met. This verifies that the information in the studies is relevant to know the environmental impacts generated in the work and which of these impacts are not avoidable, with their corresponding environmental management measures.

Control and monitoring

Projects, works, or activities subject to an environmental license or Environmental Management Plan, during their construction, operation, dismantling or abandonment, are controlled and monitored by the environmental authorities (Vallejo, 2017). Control and monitoring seek to corroborate, verify and demand compliance with the obligations outlined in the environmental license, in addition to generating additional measures not provided for in the project's environmental studies for the protection of the environment.

Importance

The importance of an environmental license to develop a civil construction project is fundamental because when developing a construction project, the environment and the community located in nearby or adjacent areas are directly affected (Ferri, da Silva, & da Rocha, 2017).

The scope of the environmental licensing system in Colombia can be considered from different perspectives since it can be: an instrument that imposes limits to the exploitation of natural resources to prevent their disappearance or superficial or permanent contamination, a tool that contributes to reduce the negative effects of the projects, an instrument of environmental planning that contributes to the fulfillment of the purposes of protection and conservation of the environment in general or authorization for unlimited use (that is, until there is no more resource) and therefore a measure of appropriation of the ecosystems (Rojas, 2013).

The impact that can be generated when developing a project on the flora can be permanent or temporary according to the project and the need for the project; when removing this resource space is visually affected, besides removing plants that could be at risk of extinction. The impact on fauna is negative because the natural habitat of animal species found in the defined area of the project is removed. It is important to implement an EDA (Environmental Diagnosis of Alternatives), an EIA (Environmental Impact Assessment), and an EMP (Environmental Management Plan) in which the solution or plan is sought to prevent or mitigate the environmental pollution problems that the project will generate (before, during, and after) during its life span. This process is necessary to obtain the license and during this process, awareness can be generated about the negative impact that a project generates on the environment and the options to minimize it.

License types

When seeking to issue an environmental license it is relevant to have knowledge of the types of license that can be obtained and which of these is relevant according to the type of project that will have an impact on the environment.

Ordinary license

An ordinary type of environmental license is that granted by an environmental authority to the benefactor, in which certain requirements and obligations are set forth for the mitigation of the greatest possible damage and compensation of those effects caused by a project on the environment for an authorized activity; however, the permit is not given to take advantage of or mobilize renewable natural resources, some of which are water, air, minerals or light. This type of license is the one needed in building construction.

Single license

In this license, the authorization is based on the prevention and control of air pollution generated in the hydrocarbon sector. This type gives the legal authority to develop a project or activity and its validity is governed by its nature. This type of license requires the free writing (Original and Copy) and the application for a single environmental license for industrial establishments under federal jurisdiction with an autograph signature (ANLA, 2017b).

Global license

The Global Environmental License is administered only by the Ministry of the Environment, which grants the licenses

that authorize mining and hydrocarbon exploitation, a type of license that gives the legal permission to exploit an area governed under some territorial limits. In this type of license, it is relevant to present an environmental management plan for the project that will affect the environment.

These are environmental licenses specifically designed for mining and hydrocarbon exploitation projects, which cover the entire area of exploitation required by such projects. In this type of license, a specific Environmental Management Plan must be presented for each of the activities and works defined, as long as it respects the environmental zoning and environmental restrictions defined in the license. This Environmental Management Plan is not previously evaluated by the authority. Some activities and works require permits, licenses, and contracts granted by other state entities, such as port or mining projects. In these cases, it is necessary to obtain the environmental license to exercise the rights which must generally be requested before the regional environmental authorities. Regional environmental authorities may not grant permits, concessions or authorizations when these are part of a project whose environmental license is under the jurisdiction of the ANLA. Environmental, so that the company can begin work and activities once the management plan has been submitted. Works and activities are subject to control and monitoring by the environmental authority. The Global Environmental License for mining operations includes the construction, assembly, exploitation, benefit, and internal transportation of the corresponding minerals or materials.

Environmental authorities

ANLA

It is the national authority of environmental licenses that was born under the need to regulate, expedite and grant environmental licenses for civil construction projects in the country, the low technical capacity with which the government had to make a detailed study and monitoring of projects, works or activities that affect the environment in which they are developed and With the arrival of the development locomotives were generated the need to expedite the process of environmental licensing and monitoring for detailed compliance with the regulations that must be followed to eliminate or mitigate environmental damage generated by a construction project in the licenses (Fig. 4).

On the ANLA website, you will find the current regulations governing environmental licenses, according to the process or medium for which it applies.

Which terms of reference are adopted for the preparation of the Environmental Impact Assessment (EIA), and the Environmental Management Plan (EMP) required for the processing of the environmental license of each civil

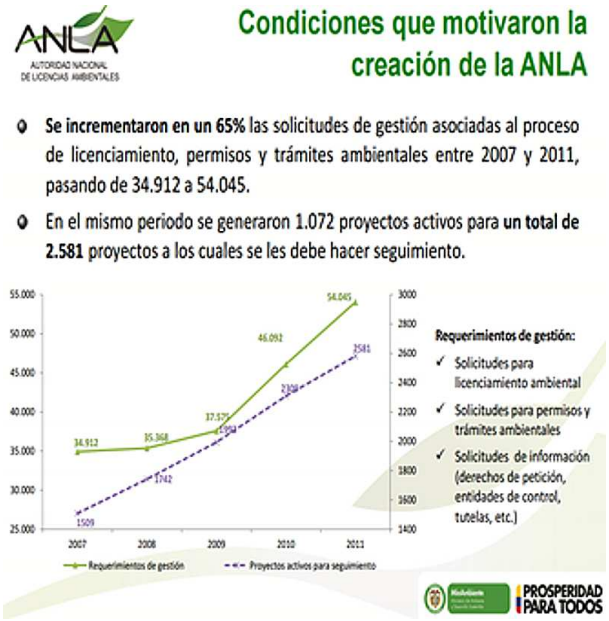


Figure 4. Reasons for the creation of ANLA (ANLA, 2017a).

construction project. In which it is shown and consolidated the model or the general methodology for the presentation of environmental studies and if the license is approved the manual of the environmental pursuit of the project.

Environmental Management Plan (EMP)

- The measures to prevent, mitigate, correct and compensate for the negative environmental impacts that the project, work or activity may cause in the environment and/or to the communities during the construction, operation, maintenance, dismantling, abandonment and/or completion phases of the project work or activity.
- The monitoring program of the project, work or activity to verify compliance with environmental commitments and obligations during the implementation of the Environmental Management Plan, and to verify compliance with environmental quality standards established in current regulations. Also, to evaluate through indicators the expected environmental performance of the project, work or activity, the efficiency and effectiveness of the environmental management measures adopted, and the relevance of the necessary and applicable corrective measures in each particular case.
- The contingency plan will contain the measures of prevention and attention of the emergencies that can be caused during the life of the project, work, or activity.
- The projected costs of the Management Plan concerning the total cost of the project work or activity and the schedule for execution of the Management Plan (ANLA, 2017a).

ISSN 1692-8407

It also sets out fees for the collection of license evaluation and monitoring services. In case of not complying with the current regulations or established environmental management plans, the corresponding sanctions will be applied with the fault.

The official website also establishes the Forest Reserve areas and they are protected by the environmental authorities, it establishes terms of reference for the different environmental management plans of the corresponding projects, adopting the requirements and evidence of contribution to the sustainable development of the country. The norms and standards of admissible emission of pollutants to the atmosphere by fixed sources are established, they indicate the criteria to delimit the fields of production of existing hydrocarbons, for effects of the application of the environmental instruments, the permissible levels of emission of pollutants are regulated that will have to fulfill the terrestrial, aerial, and marine mobile sources.

On the official website of ANLA is the regulation that prohibits the manufacture and import of equipment and products that contain or require for their production or operation the substances that deplete the ozone layer. The national standard for noise emission and environmental noise is established. Some measures are established about the handling of the tanneries and commercialization of products of the wild fauna. And the loading, unloading, transport, storage, and final disposal of rubble, materials, elements, construction, and demolition concrete and an organic layer, soil, and excavation subsoil are regulated.

VITAL

It is the Integral Window of Environmental Procedures of Colombia, which was created thanks to the Ministry of Environment, Housing and Territorial Development (MAVDT), and the CARs of the Center of Antioquia, Quindio, Northeastern Border, Nariño and Atlantic to have an online access point for the management of environmental permits and licenses. In 2010, the window for national coverage was created under the direction of the MAVDT. In 2011 the MAVDT disappears and is replaced by the Ministry of Environment and Sustainable Development, which creates ANLA and is assigned the administration of VITAL (Min Ambiente, 2017a).

ANLA is assigned the virtual tool for:

- To implement the use of this by the environmental authorities, generating training and support to integrate them into the web service.
- To carry out the control and monitoring of the use that is applied to it, using the accompaniment in the manipulation, operation, assistance, and support.
- To implement the respective adjustments that the page will demand, making activities, creating new modules, and configuring its correct operation.

The importance of this platform is to facilitate and unify the process to obtain an environmental license, this is because there are several environmental authorities and each one of them, involves different processes that can make the process difficult. Another benefit is its accessibility since it is not necessary to assume costs and long periods to be informed and know the status of the procedure.

The person or entity that is interested in applying for an environmental license through VITAL must take into account the following:

- Be registered on the platform.
- Validate your registration with the appropriate environmental authority.
- Have a bank account for online payments.
- Have access to the internet.
- Have a personal email address.
- Enable the downloading of files to the computer.

Eight environmental procedures are handled at the window (MAVDT, 2011).

- Environmental licensing.
- Prospecting and exploration of groundwater.
- Groundwater concessions.
- Surface water concessions.
- Discharge permits.
- Forest exploitation of natural forests.
- Emission permits.
- Mobilization passes.

This window will benefit the industry sector, companies, and citizens who require the license for the intervention in the environment. Also, it allows transparency, since it contains the Single Registry of Offenders which allows knowing which infractions have been committed towards the environment by companies and individuals.

It allows to corroborate the environmental licenses issued by sectors, this allows the environmental authorities to register and use the information on the environmental licenses to fight against the illegal ones that affect the environment, a case like the illegal mining that pollutes the rivers with mercury and puts at risk the life of the people who consume of its waters.

To access the benefits of this platform, registration is required. The registration is carried out by the platform and it is necessary to present itself in a regional corporation or to go to ANLA to claim user and password, this way it is had veracity of the security of each user.

As of 2013, there were 4,413 registered users at VITAL, 2,783 registered mining licenses, and 9,536 applications for environmental procedures online (Min Ambiente, 2017a).

As the platform is constantly being updated, we want to implement missing procedures, to be able to add all the environmental authorities, which total 42, and we hope to expand the online payment method because the platform has low-cost online payments. Also, it is intended that, in some

years, all environmental procedures should be carried out exclusively by VITAL, because currently most people and companies do not make use of it, due to lack of confidence in digital documents, lack of knowledge of ICT by users in rural areas. For this reason, places were created to provide training on the VITAL window, these places are located in the regional autonomous corporations and it has also been established that the procedures of "lifting of the ban on wild flora or Assessment of Feasibility of Subtraction of Forest Reserve Areas of National Order must be carried out through the Integral Window of Environmental Procedures Online (VITAL) to expedite and facilitate the processes for such procedures (Min Ambiente, 2017b).

What is a national wildlife ban? It is a restriction or regulation of the use of certain species of flora or their products, which belong to the national territory and which present restrictions for partial or temporary periods.

What is the subtraction of the forest reserve area? In Colombia there are several forest reserves, some of them are the Pacific, Central, Magdalena River, Santa Marta Snowy Mountains, Motilones Mountains, Cocuy Mountains, and the Amazon. These are areas established to protect the forests, soils, water, and wildlife, therefore, no activities can be carried out that threaten their care and generate the enrichment of some, Therefore, it is not possible to build, cut down the forests for the forest economy or change the use of the land for any other action. Therefore, the subtraction is a process in which the environmental authority studies a petition to subtract a part of these protected areas but this is given for the benefit of society or public good and for which it is necessary to remove a part of the forest or change the use of the land. The environmental authority will be in charge of studying, analyzing, and approving or rejecting the exposed request.

VITAL has had a great impact and this can be seen in the following data (Y. Rodríguez, 2016).

- Eight environmental processes have been standardized.
- 32 of the 42 environmental authorities are located in one access point.
- 5,026 users have registered.
- 6,365 offenders have been identified.
- 2,829 mining sector licenses were registered.
- 48,179 online applications (Fig. 5).

Figure 5. Environmental authorities that are part of VITAL.

Regional Autonomous Corporation (CAR)

The main objective of the CAR is to ensure compliance and timely implementation of the provisions, administration, management, and use of the environment, issued by the Ministry of Environment.

Among its main functions are:

- Execute the different environmental programs defined by the law of the territorial plan and by the ministry of the environment within their jurisdictions.
- Exercise the role of maximum authority in the area of their jurisdiction.
- Create programs that promote the protection of the environment
- To grant environmental permits or licenses for projects that modify in some way the environmental resources and also to establish up to what point these environmental licenses or permits are permissible.
- To control and monitor the use of water, soil, air, and other renewable natural resources, which will include the discharge, emission, or incorporation of liquid, solid and gaseous substances or waste into the water in any form.
- To collect, under the law, the different fines, fees, etc., for the use of environmental resources.
- Promote and execute projects for the supply of water to communities of African descent.
- To carry out analysis activities for the prevention of emergencies and natural disasters.
- Advance programs for the adaptation of high-risk areas.

At the beginning the CAR was created for the development of the region, attending to the conservation of the natural resources to assure its better technical use and an urbanistic, agricultural and industrial advance to give the region the maximum standards of life, but this law was very recently given this it became an autonomous entity in which not for being an autonomous entity it did not have inter-institutional relations with the ministry which did not favor it much since it did not influence the agricultural sector

ISSN 1692-8407

because these sectors were created in the previous decree and the access to them was not easy.

In 1991, 43 articles were defined, some of which dealt with the conservation of national wealth, since the mission of the state in society was renewed. The new constitution calls on the territorial authorities to regulate the use of the land and to dictate the necessary rules for the control, preservation, and defense of the ecological and cultural heritage of the municipality. The regional autonomous corporations are the maximum environmental authority in the regions and are granted financial and administrative autonomy. Before Law 99 there were 18 regional autonomous corporations but in the new law they wanted to attend to the particularities of each region, with Law 86 of 1987, the corporations had to assume the challenge of promoting regional development through the rational use of natural resources.

The regional autonomous corporations before Law 99 of 1993 acted autonomously since they were attached to the National Planning Department (DNP). This condition generated several situations and experiences that, in one way or another, were definitive when it came to redesigning their role in Law 99 of 1993. With a few exceptions, the corporations managed to maintain a certain distance from regional realities and political pressures, which translated into institutional stability thanks to which they could manage their resources directly, without the intermediation of any ministry; but, on the other hand, this situation generated regional pressures to assume greater responsibilities, causing a serious dispersion of the budgets and objectives of the Regional Autonomous Corporations.

Later, the SINA (National Environmental System) was created, and the issuance of Law 99 of December 22, 1993, marked the beginning of management characterized by the need to adapt the entity to the new responsibilities established in the mentioned law. The situation of natural resources advised that some entities, which the legislator considered should be the corporations, should dedicate themselves to their protection and recovery in an almost exclusive way. In effect, this law, which reorganized the National Environmental System SINA.

With this new juridical-institutional order, the initial task of the entity was oriented to promote a process of institutional transition which was materialized in the fact that it should be applied more to its condition of an environmental authority. However, for the full exercise of this function, institutional autonomy was indispensable as a basic principle, which allowed it to carry out its activities independently from its responsibilities and challenges.

Since the issuance of Law 99 of 1993, the jurisdiction of the CAR was extended to seven watersheds, which include the entire rural area of the Capital District and 104 municipalities, of which 98 are in Cundinamarca and six in Boyacá, covering an area of approximately 1,800,000 hectares, with a population of approximately 7,300,000 inhabitants (Fig. 6) (CAR, 2017).

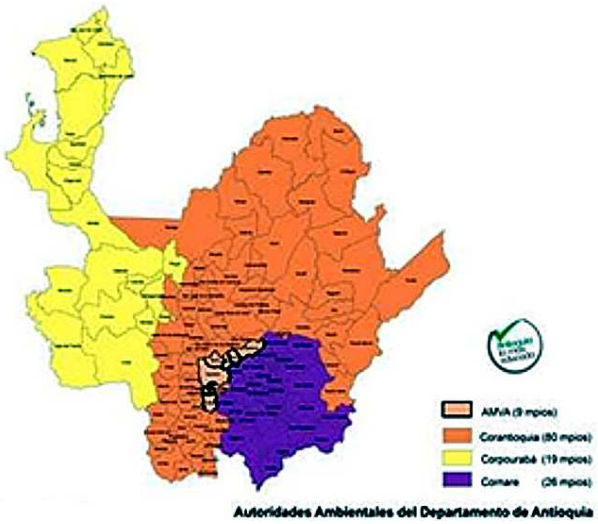


Figure 6. Map of environmental authorities in Antioquia.

Problems with obtaining an environmental license

At regional level

Having the intention of obtaining an environmental license can generate inconveniences. This can be due to the number of environmental corporations that exist in Colombia (around 42) and not knowing which corporation is in charge of carrying out the environmental procedures in the correct jurisdiction can lead to mistakes. Each corporation attends to their respective places and this must be taken into account when going to carry out a procedure. Below are the CARs with their respective jurisdiction.

CAM. It is the corporation of the Alto Magdalena that under Law 99 of December 22, 1993, was born with the jurisdiction of the department of Huila and has four headquarters, the main headquarters (Neiva), Headquarters Garzón, Headquarters La Plata and Headquarters Pitalito.

CAR. The regional autonomous corporation of Cundinamarca has created on January 31st thanks to the third law of 1961 with the responsibility of taking care of the environment in 104 municipalities, in these 98 of Cundinamarca and 6 of the department of Boyacá (Saboyá, Chiquinquirá, San Miguel de Sema, Caldas, Buenavista, and Ráquira).

This authority has diverse seats and each one has in charge certain municipalities that are presented on the page of the CAR of Cundinamarca.

- Headquarters (Bogotá D.C.).
- Bogotá D.C. Regional Office (Bogotá and La Calera).
- Regional Direction Almeidas and Municipality of Guatavita (Chocontá, Guatavita, Machetá, Manta, Sesquilé, Suesca, Tibirita, and Villapinzón).

• Alto Magdalena Regional Office (Agua de Dios, Nile, Jerusalem, Tocaima, Ricaurte, Girardot, Guataquí and Nariño.

• Lower Magdalena Regional Office (Caparrapí, Guaduas and Puerto Salgar).

• Regional Direction Chiquinquirá (Buenavista, Caldas, Chiquinquirá, Ráquira, Saboyá and San Miguel de Sema.

• Regional Direction Gualivá (Albán, La Peña, La vega, Nimaima, Nocaima, Quebrada Negra, San Francisco, Sasaima, Supatá, Útica, Vergara and Villeta.

• Magdalena Centro Regional Office (Beltrán, Bituima, Chaguaní, Guayabal de Síquimi, Pulí, San Juan de Río Seco and Vianí.

• Regional Directorate Rionegro (El peñón, La Palma, Pocho, Paime, San Cayetano, Topaipí, Villagómez and Yacopí.

• Regional Direction Sabana Centro (Cajicá, Chía, Cogua, Cota, Gachancipá, Nemocón, Sopó, Tabio, Tenjo, Tocancipá and Zipaquirá).

• Sabana Occidente Regional Office (Bojacá, El Rosal, Facatativá, Funza, Madrid, Mosquera, Subachoque and Zipacón.

• Regional Direction Soacha (Sibaté and Soacha).

• Regional Direction Sumapaz (Arbeláez, Cabrera, Fusagasugá, Granada, Pasca, Pandi, San Bernardo, Silvania, Tibacuy and Venecia).

• Regional Direction Tequendama (Anapoima, Anolaima, Apulo, Cachipay, El Colegio, La Mesa, Quipile, San Antonio del Tequendama, Tena and Viotá).

• Regional Direction Ubaté (Carmen de Carupa, Cucunubá, Guachetá, Lenguazaque, Simijaca, Susa, Sutatausa, Tausa and Ubaté).

AMVA. The Aburrá Valley Metropolitan Area was created by Departmental Ordinance No. 34 of November 27, 1980, which brought together Barbosa, Girardota, Copacabana, Bello, Envigado, Itagüí, La Estrella, Sabaneta, Caldas and Medellín. Its headquarters are in Medellín.

CARDER. It is the Risaralda Regional Autonomous Corporation, which has jurisdiction in this department, in an area of about 3600 km^2 and in which are the departments of Mistrato, Quinchia, Guatica, Puerto Rico, Belen de Umbria, Apia, Sanctuary, La Celia, Balboa, La Virginia, Marseille, Dosquebradas, Pereira and Santa Rosa de Cali. Its headquarters are located in the city of Pereira.

CARDIQUE. It is the Regional Autonomous Corporation of the Dike Channel, which in its jurisdiction is Cartagena, Turbaco, Turban Arjona, Mahates, San Estanislao de Koztka, Villanueva, Santa Rosa, Santa Catalina, Soplaviento, Calamar, Guamo, Carmen de Bolívar, San Juan, San Jacinto, Zambrano and Córdoba. Its headquarters are located in Cartagena.

Table 1 outlines the information from other CARs with details of their coverage.

On a personal level

A problem that frequently arises is the lack of information that reaches the general public or information that is false, given this, there is confusion in people when applying for an environmental license, or by falsifying, which is a serious crime and can end up in jail because they did not find out from a good source the proper information, there are training centers in the case of VITAL For people who do not know the virtual platforms that are very helpful when a concern arises.

There are inconsistencies in the State entities among the officials who evaluate the projects. For example, those who review the DAA of a project are not the same ones who analyze the EIA. This creates problems because some questions asked at this late stage have already been resolved. It is not the fault of the officials; they act in good faith because they do not know the background of a particular project. It is therefore necessary to generate a consistent evaluation between the DAA and the EIA. One of the biggest drawbacks of transmission line projects is the uncertainties with the ethnic communities, there are no set times and you cannot start working until you agree.

On the other hand, it is worth noting that the ANLA has a lot of goodwill but lacks technicians for evaluation in the area of construction and design process in general. There is a need for more trained personnel who can assist in the environmental licensing processes. This would avoid some of the delays that occur in projects. Also, the issue of deadlines is key (SCIELO, 2015).

The UPME (The Mining and Energy Planning Unit) establishes exact dates for the execution of projects, based on the country's needs. If these deadlines are not met or there is no certainty of the times employed, the problems begin. The ANLA and the competent entities have to work on setting times according to the magnitude of each of the processes. In this way, the executors can make better programming of their works. It must be remembered that the extra costs generated by these situations.

Another important problem of which we spoke previously is the time that the different entities take in the diligence of the licenses since to the being very extensive people are unwilling to continue with these procedures arriving to falsify them, on the other hand, is the breach of this licenses since if the parameters established within this one are not fulfilled it is exposed to that they take away the license, has a fine or in an extreme case they will take it to penal processes.

In other cases, constructions are made that affect the environment without any type of license or permit, other times the entities are not sufficiently aware of the licenses that they are giving and let themselves be carried away by the individual benefit, allowing them to overlook high-risk works for the conservation of natural resources.

The different entities are often not aware that the parameters established in the license are met and because of

ISSN 1692-8407

Table 1
Other CARs and their coverage.

CORPORACIÓN	JURISDICCIÓN	SEDE PRINCIPAL
Corporación Autónoma Regional de Sucre. (CARSUCRE)	Departamento de Sucre, salvo los municipios que forman parte de la Corpomojana.	Sincelejo
Corporación Autónoma Regional de Santander. (CAS)	Departamento de Santander, salvo los municipios que forman parte de la CDMB	San Gil
Corporación para el Desarrollo Sostenible del Norte y Oriente Amazónico. (CDA)	Departamentos del Vaupés, Guainía y Guaviare.	Puerto Inírida
Corporación Autónoma Regional de Defensa de la meseta de Bucaramanga. (CDMB)	Municipios de Bucaramanga, California, Charta, Floridablanca, Girón, Lebrija, Matanza, Piedecuesta, Playón, Rionegro, Suratá, Tona y Vetas	Bucaramanga
Corporación para el desarrollo sostenible del Chocó (CODECHOCÓ)	Departamento de Chocó	Quibdó
Corporación Autónoma Regional del Centro de Antioquia (CORANTIOQUIA)	Departamento de Antioquia, salvo los municipios que forman parte de Corpouraba, Cornare y el AMVA.	Medellín
Corporación para el desarrollo sostenible de la Macarena (CORMACARENA)	Territorio del Área de Manejo Especial La Macarena con excepción de las incluidas en la jurisdicción de la CDA y de Corporinoquía.	Villavicencio
Corporación Autónoma Regional del Río Grande de la Magdalena (CORMAGDALENA)	129 municipios a lo largo del Río Magdalena - 14 Departamentos	Río Magdalena
Corporación Autónoma Regional de las cuencas de los ríos Negro y Nare. (CORNARE)	Rionegro, Alejandría, Guatapé, Sonsón y San Luis en el departamento de Antioquia.	El Santuario
Corporación para el desarrollo sostenible del sur de la Amazonía. (CORPOAMAZONÍA)	Departamentos del Amazonas, Putumayo y Caquetá.	Mocoa
Corporación Autónoma Regional de Boyacá. (CORPOBOYACA)	Departamento de Boyacá, salvo los municipios que forman parte de la Car, Corporinoquia y Corpochivor.	Tunja
Corporación Autónoma Regional de Caldas. (CORPOCALDAS)	Departamento de Caldas	Manizales
Corporación Autónoma Regional del Cesar. (CORPOCESAR)	Departamento del Cesar	Valledupar
Corporación Autónoma Regional de Chivor. (CORPOCHIVOR)	Municipios de Ventaquemada, Boyacá, Turmequé, Nuevo Colón, Viracachá, Ciénaga, Ramiriquí, Jenesano, Tibaná, Umbita, Chinavita, Pachavita, Garagoa, La Capilla, Tenza, Sutatenza, Guateque, Guayatá, Somondoco, Almeida, Chivor, Macanal, Santa María, San Luis de Gaceno, y Campohermoso.	Garagoa
Corporación Autónoma Regional de La Guajira. (CORPOGUAJIRA)	Departamento de la Guajira	Riohacha
Corporación Autónoma Regional del Guavio. (CORPOGUAVIO)	Municipios de Gachalá, Medina, Ubalá, Gama, Junín, Gachetá, Fómeque y Guasca en el departamento de Cundinamarca.	Gachalá
Corporación Autónoma Regional del Magdalena. (CORPAMAG)	Departamento del Magdalena	Santa Marta, Ciénaga, Pivijay, Plato y Santa Ana
Corporación para el desarrollo sostenible de la Mojana y el San Jorge (CORPOMOJANA)	Municipios de Majagual, Sucre, Guaranda, San Marcos, San Benito, La Unión y Caimito en el departamento de Sucre.	San Marcos
Corporación Autónoma Regional de Nariño. (CORPONARIÑO)	Departamento de Nariño	Pasto
Corporación Autónoma Regional de Norte de Santander (CORPONOR)	Departamento de Norte de Santander	Cúcuta
Corporación Autónoma Regional de la Orinoquía (CORPORINOQUIA)	Comprende los departamentos de Arauca, Vichada, Casanare, los municipios de Guayabetal, Quetame, Une, Paratebueno, Chipaque, Cáqueza, Fosca, Gutiérrez, Choachí y Ubaque en el departamento de Cundinamarca y Pajarito, Paya, Pisba Labranzagrande y Cubará en el departamento de Boyacá, con la excepción del territorio de la jurisdicción de Cormacarena.	Yopal
Corporación para el desarrollo sostenible del Urabá (CORPOURABA)	Municipios de San Pedro de Urabá, San Juan de Urabá, Arboletes, Necoclí, Turbo, Vigía el Fuerte, Murindó, Apartadó, Carepa, Chigorodó, Mutatá, Uramita, Dabeiba, Frontino, Peque, Cañasgordas, Abriaquí, Giraldo y Urrao en el departamento de Antioquia.	Apartadó
Corporación Autónoma Regional del Tolima. (CORTOLIMA)	Departamento del Tolima (47 Municipios)	Ibagué, Lérida, Chaparral, Melgar, Purificación.
Corporación Autónoma Regional del Atlántico (CRA)	Departamento del Atlántico	Barranquilla
Corporación Autónoma Regional del Cauca. (CRC)	Departamento del Cauca	Popayán
Corporación Autónoma Regional del Quindío. (CRQ)	Departamento del Quindío	Armenia
Corporación Autónoma Regional del Sur de Bolívar. (CSB)	Departamento de Bolívar, salvo los municipios que forman parte de Cardique.	Magangué
Corporación Autónoma Regional del Valle del Cauca. (CVC)	Departamento del Valle del Cauca	Santiago de Cali
Corporación Autónoma Regional de los valles del Sinú y San Jorge. (CVS)	Departamento de Córdoba	Montería
Corporación para el Desarrollo Sostenible del Archipiélago de San Andrés, Providencia y Santa Catalina (CORALINA)	Departamento de San Andrés y Providencia	San Andrés isla

this many works are poorly done and soon end up causing great damage to both nature and society.

At the information level

One of the main problems in obtaining an environmental license for a civil construction project is the lack of information.

Lack of information creates doubts, or perhaps not knowing how to look for it. Throughout history, different entities or environmental authorities have been created which are in charge of processing the process of obtaining environmental licenses in Colombia. The current authority in force is ANLA (National Authority for Environmental Licenses).

It was created to expedite, process the environmental licensing processes and monitoring after the granting of the license that the laws, rules, decrees established by law are complied with, and if they are not complied with, the license must be sanctioned according to the fault and established fees or revoked if necessary.

In the official ANLA website in section *NORMATIVA*, you will find the current regulations. According to the classification of the project is established a type of license and the regulations to be met, the established parameters, and the required documentation.

In the official page of ANLA in the section *TRÁMITES Y SERVICIOS* is the documentation required to apply, according to the classification of the project is established the DAA according to the location of the project and the POT (land management plan) the latter indicates the location and use established for the land; PMA and EIA.

It is a system created to manage environmental procedures, which directs the information of the users who participate in the application for environmental licenses and permits and involves the authorities that grant them, the applicant users.

In addition to the above, the Window has other user information applications such as electronic notification and application forms for the procedures.

Steps to obtain an environmental license

Documents

For an environmental license to be accepted, all the necessary documents must be presented and properly filled out. Decree 2041 of 2014 on environmental licenses sets out the documents that are required to issue a license.

The first step that the person interested in an environmental license must follow is to know whether or not to present the Environmental Diagnosis of Alternatives, this is known by presenting the written petition to the environmental authority in charge of the jurisdiction to which it belongs. In the petition, it is necessary to annex what is the objective of the project, the tasks, requirements, and actions that must be carried out to complete the project (scope of the project) and its location using coordinates and plans.

The authority will make a decision and if the DAA is required, it will be attached along with a copy of the identification document if you are a natural person or the certificate of Existence and Legal Representation, also known as the chamber of commerce certificate, if you are a legal person (an organization with rights and obligations that exists as an institution, Fig. 7).

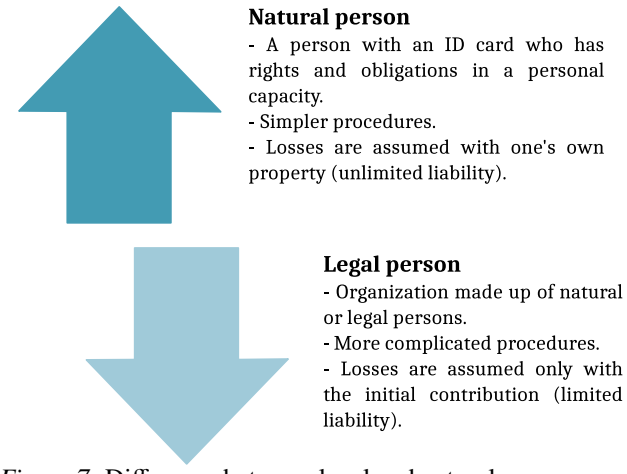


Figure 7. Difference between legal and natural persons.

Hydroelectric projects are required to submit a copy of the register issued by the Mining and Energy Planning Unit.

Once the corresponding environmental authority assesses the DAA, it will proceed to choose one of the alternatives set out in this document to prepare the Environmental Impact Study and determine the requirements.

After this process we continue with the Environmental Impact Study and with which it is necessary to add the following documents:

- Certificate from the Ministry of the Interior to notify the presence of ethnic or non-ethnic communities, as well as territories titled in the name of a community.
- Copy of the document from the Colombian Institute of Anthropology and History.
- The unique form of Environmental License
- Support plans for the Environmental Impact Study.
- Cost estimated to be spent in the investment and execution of the project.
- Evidence of payment of the service for the evaluation of the environmental license.
- Present the Format approved by the environmental authority.

For each type of project, there are different requirements when preparing the Environmental Impact Study. The CORNARE website provides the guide formats for each type

ISSN 1692-8407

of project, with 33 formats available for the preparation of the EIA.

People interested in carrying out projects related to mining need to attach a copy of the mining title or mining concession contract (it is an instrument that provides the right to exercise an economic activity, through the exploitation of a product and take profit from it). Projects related to hydrocarbons need to attach their concession contract. A concept from the National Agency of Hydrocarbons must be added, specifying whether the hydraulic stimulation activity will be carried out in a conventional or non-conventional deposit (which must use different extraction methods to the conventional ones). When the documents are presented, the environmental authority will evaluate the information that was presented and a decision will be made if it is necessary to hold a public environmental hearing, which is essential to attend and through which the process will be closed. When the application for the license is accepted at the time it is submitted, it must contain:

- The identification of the person or public or private institution to which the project was authorized and which indicates the reason for execution, activity, name, identity document, and address.
- The purpose of the project and its location.
- The summary of the considerations and reasons that were taken into account to grant the environmental license.
- The list of activities, works, and actions authorized by the corresponding environmental authority in the environmental license.
- The renewable natural resources that are approved for their use, specifying the restrictions for their use and established requirements.
- Additional requirements in the Environmental Management Plan to be fulfilled during construction, execution, and completion of the project.
- Relevant observations by the environmental authority.

Through the Integral window of Environmental Procedures of Colombia, you can carry out the procedure of the environmental license in a fast way and with help online in case of doubts that can be generated in the process.

An environmental license can be assigned to any beneficiary, which is to hand over the rights it provides and also the obligations it generates. To carry out this process the following procedure must be complied with:

- Interested parties must request in writing the authorization from the environmental authority.
- A copy certifying the assignment of the license is added to such a request.
- If they are legal persons, the certificate of existence and legal representation shall be attached.
- If they are natural persons, the photocopies of the citizenship certificates are enough.

If you intend to update information such as plans, location, cost of modification, and justification, you must enter into an Environmental License Modification process in which the following is required:

- Request by the licensee, if a legal entity the request will be made by the legal representative of the institution.
- The updated Environmental Impact Study, that is, those new processes that have an impact on the environment (if any) and the respective adjustment to the project's Environmental Management Plan.
- Proof of payment of fees for the evaluation of the project's environmental studies.

Type of license

All types of licenses must follow the following steps.

Register at the Window for Online Procedures - VITAL. The user interested in initiating a procedure must register in the application *http://vital.anla.gov.co/ventanillasilpa/*, filling out the identification form with the basic data of the natural person, private or public legal entity as appropriate and select the environmental authority to which you want to send the registration for subsequent validation and approval. The validation process requires express management of the applicant, its legal representative or proxy and can be done before the request of a procedure. See annex: Procedure for registration, validation, and approval of applicant users in VITAL).

Request a pronouncement on the need for an Environmental Diagnosis of Alternatives - DAA. Those interested in the projects, works, or activities described in Article 2.2.2.3.4.2 of Decree 1076 of May 26, 2015, must request a pronouncement on the need to present the Environmental Diagnosis of Alternatives (DAA), using a request addressed to the National Environmental Licensing Authority - ANLA.

The application must be accompanied by an executive summary with a description of the project and information related to the geographical location of the project, as established in the terms of reference for the presentation of the Environmental Diagnosis of Alternatives.

To apply through the VITAL - Window for Online Procedures, you must follow the steps below:

- Enter VITAL (*http://vital.anla.gov.co/ventanillasilpa/*).
- In the option "requests" type username and password.
- In the main menu, display the list *Iniciar trámite*.
- Select the option Environmental Diagnosis of Alternatives.
- Fill in the electronic form.

Elaboration of the required environmental study. According to Decree 1076 of 2015, the General Methodology for the Presentation of Environmental Studies, the terms of reference and the environmental regulations

in force, the user must prepare the required environmental study, which must be submitted to this Authority together with the requirements established in the mentioned Decree, to start the corresponding procedure.

Request the settlement by the service of evaluation of the required procedure. To request a settlement from the processing evaluation service, please refer to the instructions for settlement from the evaluation service.

Complete the application forms for Preliminary Verification of Documentation and Submission of AAD or, Application for or Modification of Environmental License. To apply for the procedure (DAA, Environmental License or modification) through the Window of Procedures Online - VITAL you must follow the following steps:

- Go to the online window of procedures - VITAL (http://vital.anla.gov.co/ventanillasilpa/).
- In the option *Solicitudes* type in your user name and password.
- In the main menu, display the *Iniciar trámite* list.
- Select the *Licencia Ambiental* option.
- Complete the electronic Preliminary Documentation Verification and Environmental License Application or Modification form.

When filling out the electronic Preliminary Documentation Verification form, you must attach all the supports for each of the documents required for the application, for which you must take into account the indications for the presentation of documents and the guide provides Geographic Information.

Attend the Preliminary Documentation Verification - VPD results presentation meeting. Once the information has been entered through the Online Comprehensive Procedures Window - VITAL (http://vital.anla.gov.co/ventanillasilpa/), the meeting for the presentation of the results of the Preliminary Document Verification is convened via e-mail registered at VITAL. This meeting will be held taking into account the following time distribution, in working days:

- **Day 1**: filing of the application for Preliminary Verification of Documents - VPD.
- **Days 2, 3 and 4**: preliminary verification of documentation.
- **Day 5**: meeting to present the results of the Preliminary Document Verification - VPD.

The results presentation meeting requires the attendance of the legal representative or proxy to receive the Preliminary Documentation Verification Form and, if approved, to be notified of the Initiation Order.

If the information is not approved, it will be returned through the Preliminary Document Review Form and the user will have to start the procedure again.

Notify yourself of the Order initiating the process of evaluation of the application. In the meeting of socialization of the results of the preliminary verification of the documentation that make up the application for the procedure, which will be cited by the ANLA, you will be informed if the attached documents meet the requirements established to initiate the process of Environmental License; in case of compliance, in the course of that meeting, the ANLA will immediately proceed to issue the administrative act of initiation of the required procedure.

Start of the evaluation of the environmental viability of the project. The ANLA, through specialized professionals, begins to carry out the environmental evaluation to determine the viability or not of the project, work, or activity. The evaluation is carried out both in documentary form and through a technical visit to the field. Similarly, other entities may be asked to make a statement to obtain sufficient elements of judgment for their decision.

Attend the meeting to request additional information, if required. The applicant, his legal representative, or agent must attend the above-mentioned meeting utilizing an official letter, in which the additional information required to carry out the complete analysis of the required procedure will be established.

Any decision taken at this meeting shall be notified orally and minutes shall be kept of the decisions taken and the circumstances in which such decisions were notified. Likewise, against the decisions adopted in this meeting by the environmental authority, the pertinent appeal for reversal shall proceed, which shall be resolved at the same meeting, and recorded in the minutes.

In order to submit the Additional Information through the VITAL - Online Processing Window, you must follow the following steps:

- Go to the online window of procedures - VITAL (http://vital.anla.gov.co/ventanillasilpa/).
- In the option *Solicitudes* type in your user name and password.
- In the main menu, display the *Otras actividades* list.
- Select the option *Enviar Información a la Autoridad Ambiental*.
- Fill out the electronic form by selecting the file of the procedure.

Adjust the Environmental Study according to the request for additional information and submit it again. In case additional information has been required, the user must adjust the environmental study and deliver it again (through VITAL).

Once the additional information is submitted, under the terms established by the Authority, it will be verified following the provisions of the General Methodology for the Presentation of Environmental Studies, the terms of reference, the Geographic Information Delivery Guide, the minutes of the request for additional information, the environmental regulations in force, among others, to

ISSN 1692-8407

determine the environmental feasibility of the project, work or activity, under the provisions of Article 2.2.2.3.6.2. of Decree 1076 of 2015.

Notify yourself of the administrative act communicating the Authority's decision. Once the evaluation process has been completed by the Environmental Authority, a technical concept is used to determine the viability or otherwise of the environmental license. This technical concept is accepted through an administrative act, which is later notified to the applicant, in the terms of Law 1437 of 2011, by which the Code of Administrative Procedure and Administrative Litigation is issued. If you wish to know the types of notification, please refer to the document.

Conclusions

To apply for a license before an environmental entity, parameters and laws established by the state must be taken into account, which seeks to mitigate or eliminate the damage that a civil construction project generates in the environment and that affects the community in general. By processing the required documents, actions are implemented that seek to generate awareness of the damage generated in the flora, fauna, and community in general.

The previous sections mention the environmental entities in charge of processing the environmental licenses and/or permits, according to their classification by type of project and location. parameters established in ANLA. problems for obtaining or revoking the environmental license and/or permit. And the necessary documentation according to the type of project and license.

With this document, we seek to create a guide for the community that wishes to orient itself at the moment of applying for an environmental license, but it is not a norm that should be followed legally since the laws change constantly and with them the formats and/or documentation that should be delivered to the entity in charge of processing the license. Basic information is provided about the formats and processes to be followed, classification, and types of licenses. If better guidance is desired, the applicant should approach directly the nearest environmental authority and request detailed advice.

References

ANLA. (2017a). *Autoridad nacional de licencias ambientales.*

ANLA. (2017b). *Trámites y servicios de una licencia ambiental.*

Balaguera, S., Espinosa, A., Morales, M., Seijas, A., Lasso, C., Antelo, R., et al. (2017). Conservation status and regional habitat priorities for the orinoco crocodile: Past, present, and future. *PLoS ONE*, *12*(2).

Boron, V., Tzanopoulos, J., Gallo, J., Barragan, J., Jaimes, L., Schaller, G., et al. (2016). Jaguar densities across human-dominated landscapes in colombia: The contribution of unprotected areas to long term conservation. *PLoS ONE*, *11*(5).

CAR. (2017). *Corporación autónoma regional de cundinamarca.*

De Pourcq, K., Thomas, E., Arts, B., Vranckx, A., Léon, T., & Van Damme, P. (2015). Conflict in protected areas: Who says co-management does not work? *PLoS ONE*, *10*(12).

Delgado, M., Oteros, E., Vanwildemeersch, P., Ortíz, C., London, S., & Escalante, R. (2015). Local perceptions on social-ecological dynamics in latin america in three community-based natural resource management systems. *Ecology and Society*, *20*(4).

Ezzine-De-Blas, D., Wunder, S., Ruiz, M., & Del Pilar, R. (2016). Global patterns in the implementation of payments for environmental services. *PLoS ONE*, *11*(3).

Ferri, C., da Silva, G., & da Rocha, L. (2017). Administrative discretion and environmental license. *Revista Direito Ambiental e Sociedade*, *7*(2), 255-294.

Invierta en Colombia. (2017). *Manual de licencias ambientales en colombia.*

Martínez, J., & Martínez, F. (2013). Optimization of maintenance management of trees in power distribution systems. *Tecnura*, *17*(35), 12-25.

Martínez, J., & Martínez, F. (2014). An intelligent decision support tool for management of tree maintenance in power systems. *Visión Electrónica*, *8*(1), 111-124.

MAVDT. (2011). *Ventanilla integral de trámites ambientales en línea.* (VITAL)

Min Ambiente. (2017a). *Punto único para la gestión detrámites ambientales en el territorio nacional.*

Min Ambiente. (2017b). *VITAL.*

Pagiola, S., Honey, J., & Freire, J. (2016). Evaluation of the permanence of land use change induced by payments for environmental services in quindío, colombia. *PLoS ONE*, *11*(3).

Rodríguez, G. (2017). *Las licencias ambientales y su proceso de reglamentación en colombia.*

Rodríguez, Y. (2016). *Ventanilla integral de trámites ambientales en línea.* (IDEAM)

Rojas, D. (2013). *Licencias ambientales en colombia: límites o autorizaciones para el uso de los recursos naturales.* (Universidad Nacional de Colombia)

SCIELO. (2015). *Problemas en el licenciamiento.*

Vallejo, G. (2017). *Decreto-número-2041.* (Min ambiente)

Villalobos, C. (2016). *Resumen del decreto 2041 de 2014 sobre licencias ambientales.* (Justicia Ambiental Colombia)

Zarate, T., & Maldonado, J. (2015). Valuing blue carbon: Carbon sequestration benefits provided by the marine protected areas in colombia. *PLoS ONE*, *10*(5).

Tekhnê
July - December 2018, Vol. 15, No. 2, pp. 39 – 44

ISSN 1692-8407

Technological implications, monitoring, and control in today's societies

Implicaciones tecnológicas, vigilancia y control en las sociedades actuales

Cristian C. Carrillo A.
Universidad Distrital Francisco José de Caldas
cccarrilloa@correo.udistrital.edu.co

Technological innovations and technoscience or (new technologies) are breaking all the natural human development, pointing out that the most natural thing of lacking strength. Essential features of knowledge and information are being, or have already been, supplanted as in communication. But the most worrying thing is the low interest of societies regarding these issues in general, therefore this article intends to highlight these approaches in society, the concept of technology, its association with the implications, interaction with societies and the problems caused by dependence, originating a radical solution to this type of problems.

Keywords: Control, identity, information, problem, society, technology

Las innovaciones tecnológicas y las tecnociencias o (nuevas tecnologías), están rompiendo todo el desarrollo natural humano, señalando que lo más natural del ser carece de fuerza. Rasgos esenciales del conocimiento y la información están siendo suplantados, o ya lo fueron, como en la comunicación. Pero lo más preocupante es el bajo interés de las sociedades respecto a estos temas en general, por lo tanto este articulo pretende resaltar esos enfoques en la sociedad, el concepto de tecnología, su asociación con las implicaciones, interacción con las sociedades y los problemas ocasionados por la dependencia, originando una solución radical a este tipo de problemas.

Palabras clave: Control, identidad, información, problema, sociedad, tecnología

Article typology: Research

Date manuscript received: December 6, 2017
Date manuscript acceptance: April 13, 2018

Research funded by: Universidad Distrital Francisco José de Caldas (Colombia).

How to cite: Carrillo, C. (2018). *Technological implications, monitoring, and control in today's societies*. Tekhnê, 15(2), 39 -44.

Introduction

Highlighting the change from natural human knowledge to artificial human knowledge is as important as the development of civilizations (Lu & Chen, 2017; Pert et al., 2015). This is because from this measure one can see the loss of human characteristic features or the degree of affectation (Chang, Kahle, & Hirsch, 2015). Therefore, it is important to recognize the conception and variation of such knowledge over time, because the only way to differentiate ourselves from other species is our ability to think or reason, and not skill by instinct (Amiot, Sukhanova, Greenaway, & Bastian, 2017; Prokop & Fancovicova, 2017). Thus, some consequences of the innovations are presented, such as the technologies that supplant a person's abilities, that is, the exclusion generated to man by this type of technologies, and a certain degree of surveillance and control given by technological management, are factors that will be presented in the article, demonstrated and developed.

Technological implications from two perspectives

In technology the implications or the *impact generated in society*, are developed as a second face taken into account by many as not very worthy of attention, this discredit as well as human expansionism regarding social development, are altering the essence of human characteristic features, such as bad communication between people as a result of social networks (which depend on their ability to observe human behavior, acquire information and sell that data to others), or the development of different ways to damage and end human life, some have considered the idea that the more technology we have the more we will lose our real identity.

The concept is congruent with that of technological revolution since only during the periods of greatest technical innovation is the difference in the pace of development between the two and the transcendence that exists between the generic concepts of evolution and revolution. During most of the history of mankind, the pace of such innovations was slow; however, since the Second World War mankind has experienced exponential growth in the use and development of technology.

Indicators of technological evolution reached by a civilization, express the degree of affectation, such as the different crises in today's societies resulting from the development of technology and innovations that give rise to a certain degree of surveillance and control. The importance of intellectual property plays a fundamental role, so the rapid expansion of data processing or the bits of personal data converted into highly fluid and mobile double data by the control society express the degree of interaction and dependence, forms of control such as entertainment and consumption originate the concept of surveillance, thus trying to highlight the importance of the implications *in the modern world*.

In the voice *technology*, understood as (technique or technology) a conception stands out, stories of Icarus, Daedalus and Prometheus illustrate an ambiguous conception about the valuation of the technique in the antiquity followed by a disdain for the physical work what led to all type of human being who used of his physical force to occupy the seventh place in the nine genres of life proposed by Plato (Arancibia & Verdugo, 2012), in the Middle Ages this way the work was considered, But in the contemporary world, physical work became necessary for the production of artifacts, to cover needs and generate wealth. Behind this form of subsistence, social problems appear, which provide the rich with opportunities concerning a thirst for power and control that is a product of technological innovations, since these separate human beings into economic and social classes, generating a break in natural relations, that is, in the capacity to relate naturally.

In ancient times it was thought that if an acquired knowledge was rationally contemplated by our soul, it was disposed as a true knowledge which implied reasoning, from the industrial revolution and the introduction of technologies to societies (Arancibia & Verdugo, 2012), which implied an appropriation of knowledge and remuneration for the work done, this knowledge went from being globalized to being isolated, excluded and given or taught in a very reduced way, that's why a person was forced to perform work with a low knowledge of such work to be paid and cover their own needs, of course, this was after the economy and sales of goods in society developed.

Currently, there is a union of the two perspectives, knowledge in reasoning, globalized but very reduced, this implies that societies are under the control of the highest social classes which continue to strengthen through technological management indicating the relationship technology/power/wealth, who does not have technological means is forced to a degree of subordination and also more exposed to changes in their environment.

General concept

Processes such as the industrial revolution, the great economic and social phenomenon that occurred in the mid-18th and mid-19th centuries, arise from the study of the techniques used in past and present times, and even more, intellectual assumptions that make possible the constant improvement of iron theories or their constant relationship in political, economic, social and natural aspects that, according to the minds of the ancient Greeks, made it possible to differentiate the experience of technology and apply scientific knowledge to technology to create something integrated and provide solutions to the constant need of being.

ISSN 1692-8407

According to Plato, techne only imitates ideas that focus knowledge from the creation or improvement of an object, such objects have three kinds of techne, namely, that of their use, that of their manufacture, and that of their imitation (Arancibia & Verdugo, 2012). Thus, the work of a shoemaker is more meritorious than that of a painter because they are dedicated to imitating, however, the most experienced is the one who uses it and not the one who invents it. After all, he acquires greater knowledge through experience.

According to Aristotle, techne was not about doing things, but about knowing how to do them, since an architect possesses theoretical and rational knowledge (Arancibia & Verdugo, 2012), mainly mathematical, which he acquired through special learning and which even more fundamentally he can transmit in the same way, this type of knowledge differs from experience since this is a more universal knowledge.

Thanks to these approaches of Aristotle and Plato concerning techne and its importance, the valorization of this knowledge increased. This led to a greater focus on technical and technological conception in antiquity.

Exercising on the natural a change towards the artificial, but even more with so much current development and the lack of it arises a coherent idea that takes out of the innovations a social problem, which resembles the constant displacement that some prototypes are causing in human beings, consequently, we use the computers to save the information and we forget to retain that information in our mind, we forget to introduce reading and deduce its content by the -seeking- something simple and summarized in the information network, we have left our intelligence at the mercy of change and in such development, every moment we are more affected by technology, every moment creates more needs.

Technological implications

According to Evandro Agazzi (Agazzi, 1998), technology as such is not something modernist, because its root lies in the need to give a reason, to realize. Originating the *invention of the why* is the factor that originates at the same time, philosophy in the western sense (not as wisdom although it can also have this interpretation) and science understood as knowledge, that is to say, it originates that knowledge that wants to be guaranteed, that is to say, to be within the truth and also to know why this is the truth.

Technology is a structural element of modern scientific knowledge, but beyond its structural relationship it takes in first instance the conception of modern science and is characterized by the fact that when something is stated, it has to be found out either as experimental science or applied science, that is, His experiments are carried out employing instruments generating an artificial situation so that an industrialized world becomes an environment completely alien to nature, *the technique that advances precisely by accumulation, modification and empirical transmission* is precisely this and consists basically of the construction by a man of an *environment* to cover part of his desire. The use of technology is not usually accompanied by knowledge of the reasons that justify *here the transition from technique to technology* and the efficiency of certain practices that are carried out. Thus, in the development of western civilization, the moment came when the simply practical dimension was added to the concern of knowing why it is better to do things in a certain way, which was called techne, being, a set of effective knowledge that is also accompanied by the knowledge of the reasons or causes why the procedure is effective or not (Quintanilla, 2017).

Impact of technology

After the historical discovery and evolution of modern natural science, given in the western civilization was applied to the technique the lodge suffix since in the Greek civilization existed more than the pure accumulation of experiences that were transmitted from generation to generation, recognizing that there are those who, besides knowing about the existence of certain effective procedures, know why they are, thanks to this suffix which wants to indicate a certain elaborated doctrine or a theory about the matter in question, technology comes to light which is more than skill or know-how, and knowledge of how to do is used, that is, it is not applying technical knowledge, it is applying scientific knowledge to technical things.

When it is stated that technology is a structural element of modern scientific knowledge, already in its beginning modern science reveals itself to be structurally connected to technology, because, first of all, it is necessary to invent, to build an instrument to *observe* nature. Secondly, the scientific *experiment* consists in the realization of an artificial situation, precisely because only within an artificial situation can one put in view what is never seen in a natural observation. Thus, experimental science is a science that already, in its birth certificate, has technology written in its roots. Evandro Agazzi, 1998, modern science appreciates observation very much, but on the condition that it is *exact*, that is, instrumental, and expands it fundamentally when it includes in what is observed, especially the consideration of the results of the experiments.

Newton develops all the consequences. In the third book of optics, in his methodological considerations, he states that in natural philosophy (as was said in his time) one must be content with generalizations obtained from phenomena. There is no longer any talk of universal principles that can possess a more guaranteed solidity than phenomena. It is these that have the decisive force. The change is therefore truly important, since before it was the theory that had the

strength and the experience that had to settle its accounts with the theory.

Scientific knowledge is constructed as objective knowledge in the following sense (Agazzi, 1998): no science deals with reality in its totality but only with its specific objects, and these objects result from considering reality from certain points of view. These concepts must be accompanied by operations of observation and measurement, to refer to reality, Then the experiment is achieved, reaching the concrete and it is then when the object is constituted. Thus, the physical object is physical in the sense that we speak of it with predicates and reference criteria used in physics or the historical object that always refers to operations of consultation of archives, documents, etc (Quintanilla, 2017). This is why technology is so important, since it allows any empirical science to construct its scope of objectives and also provides a basis for them.

Scientific truth is constructed as a consequence of many statements as scientific theories can be considered true or false in a special sense, considering the results of these statements as technological products (Agazzi, 1998). In the works of epistemology, it is said that there is a moment when a hypothesis is formulated, and then, with it, the facts that have caused the raising of such questions are explained. Some refer to this process as a degree of confirmation of the hypothesis, others, the Popperians, say that the truth of the hypothesis cannot be concluded and speak of a degree of corroboration, although they all refer to the same idea, namely, that we are not certain but that a situation of probability can be reached in which a certain function is fulfilled. Such a situation consists in the fact that we have many successful forecasts. And the technological products are the realizations of the success forecasts of scientific theories. Therefore, from this point of view, technology, through technology products, constitutes the strongest basis for accepting most of the current scientific theories, and it does not only refer to the practical use of their applications.

Technology has transformed our way of understanding science, knowing the typical product of modern science as the machine which is not something that subjugates or submits to nature but substitutes it and starting from the utopia that man can dominate nature, this would be wrong since it can be considered that the machine performs better and faster the process than nature itself the corresponding processes or tasks. Therefore what happened was not the domination of nature to put it at the service of man, the machine has an enormous advantage: inside it, there are no secrets, everything is known, perhaps not to me but the technician or specialist. If it breaks down, it can be repaired, because it is built according to a project that allows us to know how it works and to return it to its original state (Agazzi, 1998).

Technology has profoundly changed the way of understanding scientific explanation, this consists of elaborating a machine model for almost everything, it has also notably changed the way of understanding the concept of observation (Observation cannot be reduced to perception, because observation consists of attributing to something the result of what is perceived, of concept and perception), observation requires, therefore, an integration of all our faculties.

We can thus see how technology has changed the concept of observable and unobservable (Agazzi, 1998), observable is always that which can be observed through instruments, whose properties are perceptible by the senses, the scientific object is attributed properties that depend indirectly on the results of observation and measurement, but are not seen.

If we attribute to something a mass or an electric charge, such things cannot be seen but are calculated (Agazzi, 1998). Therefore, the scientific object results as a set of all these predicates, none of which is visible, but each of them is revealed through the instruments. Without this perspective, it is not possible to understand the current way of doing science, in which it can be seen very clearly how it depends on technology.

Technology and scientific knowledge

Ancient natural science was typically an observational science (Agazzi, 1998), and modern science is not an observational science in that sense. The scientific observation of modern natural science is something different because it is an observation–instrumental–a fundamental principle of the scientific methodology of the whole classical tradition was the following: nonfit scientia per visum solum, there is no science, or knowledge, only through sight or observation, because it is not through simple observation that these aspects are obtained, and that is the fundamental point. An ideal construction must be carried out, an experimental situation must be created, that is to say, an artificial situation, in which the mathematical factors can be revealed in an isolated and clear way because the common *experience* does not provide any of these ideal or pure situations.

That is, technology is included in the structure of science or this new way of knowledge. Therefore, technology is more than applied science: it is also that, but it also focuses, very deep paths within the very structure of scientific knowledge.

Surveillance concept in the modern world

In society, surveillance is constituted as a key dimension or factor, in many countries, people are aware of how surveillance affects their lives and influences human behavior and reasoning since simple purchases or simple online access are the product of *marketing* strategies that in today's society are generated by companies or organizations of any kind

ISSN 1692-8407

to guarantee the user a full need for consumption since surveillance has been blurred especially in this consumerist sphere.

According to Bauman Zygmunt and Lyon Davis (Bauman & Lyon, 2013), surveillance in pre-20th century times was not as globalized as it was since the 9/11 attack in New York. Since then, surveillance has been spreading in unimaginable ways, responding to liquidity, but under pressure from the demands of security and control since then "security" has become more rigid, According to this, the current societies belong to the post-panoptic model, since unlike the panoptic model (being this only a model of surveillance) it does not require surveillance governed by the physical, that is to say, it is not necessary to be present in a given place to exercise a certain control that guarantees security.

The continuous improvement of a process or product which gives companies or organizations the ability to stay in the market, being the case of electronic technologies that constitute the power of mobile organizations in a way that uses the information to exercise surveillance, consequently fades into human needs. William Staples has also noted that today's surveillance occurs in cultures characterized by fragmentation and uncertainty, where the traditional meanings, symbols, and institutions of modern life dissolve before us. Thus, all the bonds, structures, and everything stable become liquid.

As an example of the above in education, Bauman starts from what he calls the syndrome of impatience, a state of mind that considers as abominable the waste of time, towards the consumerism characteristic of these times, it is not defined by the accumulation of things, but by the brief enjoyment of these, from this vision education is seen as a product more than a process, thus education seems to abandon the notion of useful knowledge for all life to replace it with the notion of knowledge of using and throwing away. Education should be a continuous action of life and not dedicated exclusively to the development of technical skills. According to this, technological innovations are displacing natural human traits as in communication.

Impact on society

Security today has become a business that deals with the future and relies on surveillance to control what will happen, using digital techniques and statistical logic, but who is responsible for this surveillance, the software designers ensure only handle the data so that their activity becomes morally neutral and their actions reasonable. According to Didier Bigo, this type of security operates by tracking everything that moves (products, information, capital, humanity) (Bauman & Lyon, 2013). Bauman states that in liquid modernity power must be free to flow, and barriers, borders, and checkpoints are an obstacle to be overcome or circumvented. To do so, he needs to expurgate the dense networks that form social bonds, which exist fundamentally within the limits of a territory. For him, it is the fragility of these links that allows power to be imposed.

So, to what extent does the notion of liquid modernity (and liquid surveillance) help us understand what is happening in the world of monitoring, tracking, search criteria, data checking, and systematic observation that is surveillance? The answer is 'the context'. It is easy to see the expansion of surveillance as a technological phenomenon or as something associated with *social control* or *Big Brother*. But in doing so, the emphasis is on the tools and the tyrants, and the spirit that drives surveillance, the ideologies that promote it, the circumstances that make it possible, and the ordinary people who accept it, questions it, or decide that if they cannot beat it, they will join it, is ignored (Bauman & Lyon, 2013).

By 2020 a goal is presented in a public magazine by the (state) in which it is supposed to laminate the currency and with it all forms of payment that have survived from the great industry or industrial development, giving us an idea of security that lies in the consideration of a more timely and profitable economic form, but this is only a new form of monitoring and control since with this you can safely control the quality of life of people and their income, But society faces another problem that is not due to its environment but is of internal cause as a simple notion, people like to be watched this supposes, how to end the surveillance in a society that likes to be watched turning the being into (just a human hyperlink), social financial budgets, are possible thanks to the transactions, income, payments, withdrawals made at the bank, which are given to the government as a requirement. Society must be more aware of how technological innovations, social networks, consumption, the unstoppable need is affecting their lives because only with actions can change be managed, and thus not allow the natural features to disappear.

The new surveillance (Bauman & Lyon, 2013), based on processing, information, rather than on what Foucault stated, allows for new transparency in which not only citizens as such but all of us, in each of the roles we assume in our daily lives, are constantly controlled, observed, examined, evaluated, assessed and judged.

Conclusions

In today's power relations those who control the levers of power can at any moment become unreachable, live in pure inaccessibility, but this unequal treatment of power, which maintains poverty and misery in its current state, can be ended from the moment that, in large quantities, the reasoning of change and progress is given. Thus, with reflection and knowledge, we can break with the artificial. It is important to question, not to completely accept everything

that is said to cover a need because this may generate more needs instead of covering them.

In an intellectual society, in which several human characteristic changes have taken place, the factors of technological development are as important as the very need of man, I speak of a society where one is so exposed to the form of government, it is necessary to exercise a rigorous change a break of the post-panoptic culture. From the neoliberal model, which supposes to be the strongest economic and social model, several methods have been planted to finish it as, diffract the neoliberal model exposed in the book Neoliberalism in Latin America, and the simple fact that it continues in force, it can be concluded that the need of the people is stronger, and this is one of the causes why the society is so vulnerable to the changes.

To what extent is the notion of liquid surveillance useful for glimpsing what is happening in the world of monitoring, tracking, tracing, classification, verification, and systematic observation that we call surveillance? Compared to solid modernity, 150 or 200 years ago when everything seemed more durable, more enduring. Some philosophers and theorists have shown how surveillance, apparently solid and fixed, became much more flexible and mobile, filtering through and extending to many areas of life that were previously hardly affected.

References

Agazzi, E. (1998). El impacto epistemológico de la tecnología. *Revista española de ciencia, tecnología y sociedad, y filosofía de la tecnología*(1), 17-32.

Amiot, C., Sukhanova, K., Greenaway, K., & Bastian, B. (2017). Does human–animal similarity lower the need to affirm humans' superiority relative to animals? a social psychological viewpoint. *Anthrozoos*, *30*(3), 499-516.

Arancibia, M., & Verdugo, C. (2012). *De la técnica a la tecnología*. Trotta.

Bauman, Z., & Lyon, D. (2013). *Vigilancia liquida*. Paidos.

Chang, E., Kahle, E., & Hirsch, J. (2015). Understanding how domestic abuse is associated with greater depressive symptoms in a community sample of female primary care patients: Does loss of belongingness matter? *Violence Against Women*, *21*(6), 700-711.

Lu, D., & Chen, X. (2017). Interpreting and extracting open knowledge for human-robot interaction. *IEEE/CAA Journal of Automatica Sinica*, *4*(4), 686-696.

Pert, P., Ens, E., Locke, J., Clarke, P., Packer, J., & Turpin, G. (2015). An online spatial database of australian indigenous biocultural knowledge for contemporary natural and cultural resource management. *Science of the Total Environment*, *534*, 110-121.

Prokop, P., & Fancovicova, J. (2017). Animals in dangerous postures enhance learning, but decrease willingness to protect animals. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(9), 6069-6077.

Quintanilla, M. (2017). *Tecnología: Un enfoque filosófico y otros ensayos de filosofía de la tecnología*. Fondo de Cultura Económica USA.

Tekhnê
July - December 2018, Vol. 15, No. 2, pp. 45 – 58

ISSN 1692-8407

Ecology, construction, and innovation: An alert towards change

Ecología, construcción e innovación: Una alerta al cambio

Victor M. Guerrero
Universidad Distrital Francisco José de Caldas
vguerrero349@gmail.com

Wilson A. Sánchez
Universidad Distrital Francisco José de Caldas
wilsonandressancheza@hotmail.com

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

Article typology: Research

Date manuscript received: December 8, 2017
Date manuscript acceptance: April 13, 2018

Research funded by: Universidad Distrital Francisco José de Caldas (Colombia).

How to cite: Guerrero, V., Sánchez, W. (2018). *Ecology, construction, and innovation: An alert towards change*. Tekhnê, 15(2), 45 -58.

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

ISSN 1692-8407

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).

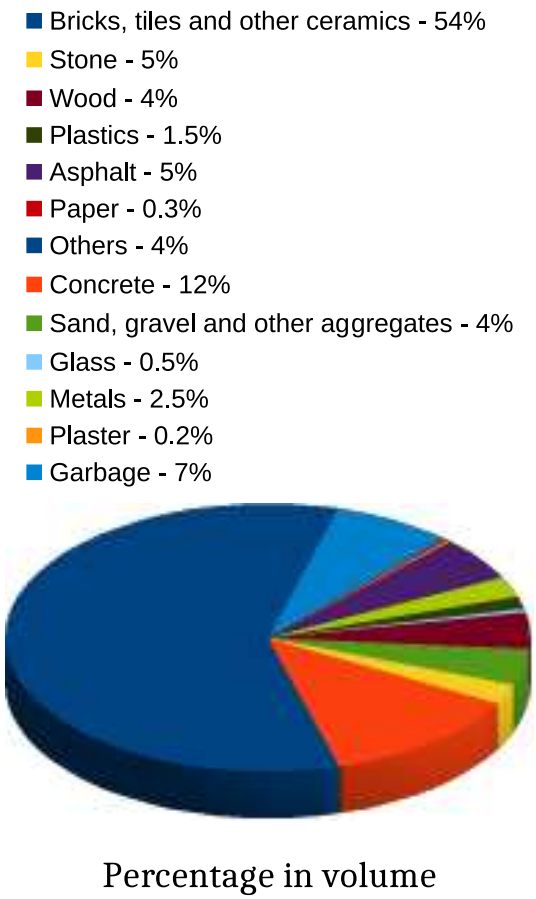


Figure 1. Percentage in volume of material deposited in landfills (modified) (Romero, 2006).

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

ISSN 1692-8407

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.

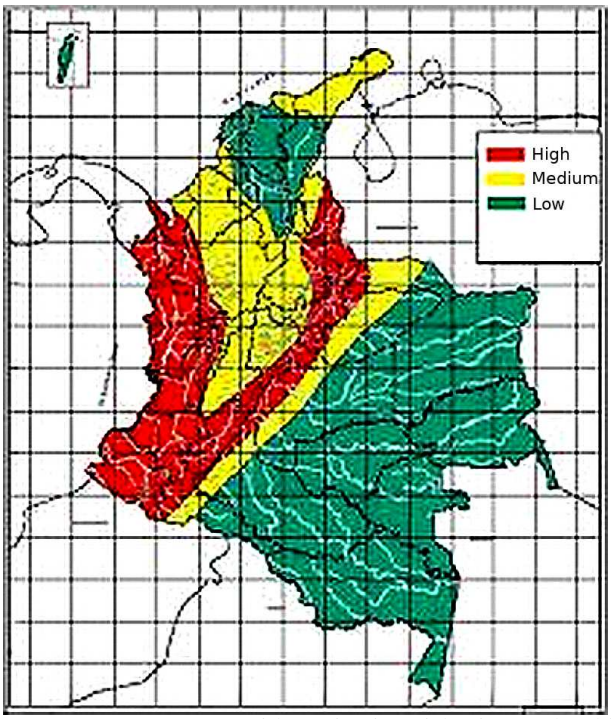


Figure 2. Areas with seismic risk in Colombia (Gerdau Diaco, 2012).

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

ISSN 1692-8407

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,

ISSN 1692-8407

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.

References

Administración Forestal (FSC), C. de. (2017). *¿cómo sería un mundo sin árboles?*

Agudelo, C., Ramos, H., & Merchán, R. (2014). Hacia el mejoramiento de las prácticas de construcción en la producción informal de vivienda: el caso del proyecto construya, de swisscontact. *Traza*, *5*(10), 10-27.

Argüello, M. (2004). *Riesgo, vivienda y arquitectura.* (Desenredando)

Barbara, C. (2003). *Riesgo y seguro en la construcción de infraestructuras civiles.* (Informe Técnico)

Blanco, L., Miranda, V., Barraza, A., Junger, W., Hurtado, M., & Romieu, I. (2014). Effect of socioeconomic status on the association between air pollution and mortality in bogota, colombia. *Salud Pública de México*, *56*(4), 371-378.

Botella, A. (2017). *Guía de buenas prácticas ambientales en el diseño, construcción, uso, conservación y demolición de edificios e instalaciones.* (Red Sustentable)

Cabo, M. (2011). *Ladrillo ecológico como material sostenible para la construcción.*

Cardona, D., Vela, J., & Martínez, F. (2015). Respaldo eléctrico con recursos renovables: estudio de viabilidad. *Visión Electrónica*, *9*(1), 113-127.

Cui, W., & Caracoglia, L. (2016). Exploring hurricane wind speed along us atlantic coast in warming climate and effects on predictions of structural damage and intervention costs. *Engineering Structures*, *122*, 209-225.

El País. (2012). *Cartago. al norte del valle del cauca, sigue sumida en los escombros.*

El Tiempo. (1998). *Falta conciencia ambiental.*

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.		

ISSN 1692-8407

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**

Fernández, G., Rodríguez, F., Acosta, F., Delgado, J., Beerzosa, A., & Barandica, J. (2010). Emisiones de co2eq como indicador de sostenibilidad en infraestructuras lineales. In *Xiv international congress on project engineering*.

Franco, J., Segura, J., & Mura, I. (2016). Air pollution alongside bike-paths in bogotá-colombia. *Frontiers in Environmental Science*, *4*.

Gerdau Diaco. (2012). *Mapa de amenaza sísmica y reglamentación colombiana al respecto.*

Giordani, C., & Leone, D. (2017). *Ingeniería civil.* (Universidad Tecnológica Nacional)

Goenaga, N., Paz, M., & Sandoval, H. (2011). *Los 10 pecados de contratistas para ganarse las licitaciones.* (Construdata)

Gueguen, L., & Hamid, R. (2016). Toward a generalizable image representation for large-scale change detection: Application to generic damage analysis. *IEEE Transactions on Geoscience and Remote Sensing*, *54*(6), 3378-3387.

ICONTEC. (2006). *Ntc iso 14040.* (Instituto Colombiano de Normas Técnicas)

Kurgan, L. (2017). Conflict urbanism, aleppo: Mapping urban damage. *Architectural Design*, *87*(1), 72-77.

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

Marrero, M. (2017). *Diseño y riesgos. hacia una arquitecura pertinente.*

Martinez, F., Martinez, F., & Hernandez, C. (2017). Organic-shaped structures design using genetic algorithms and metaballs. *Contemporary Engineering Sciences*, *10*(21), 1001-1010.

Martínez, F., Montiel, H., & Jacinto, E. (2016). Inductive teaching and problem-based learning as significant training tools in electrical engineering. In *Smart education and e-learning 2016* (p. 179-188). Springer International Publishing.

MinAmbiente. (2012). *Criterios ambientales para el diseño y construcción de vivienda urbana.* (Ministerio De Ambiente y Desarrollo Sostenible)

Oreja, J. (2011). *Filler de aluminio para la elaboración de ladrillos puzolánicos sin cocción.* (Universidad Pública de Navarra)

Rodríguez, F., & Fernández, G. (2010). Ingeniería sostenible: nuevos objetivos en los proyectos de construcción. *Revista ingeniería de construcción*, *25*(2).

Romero, E. (2006). *Master ingeniería ambiental, residuos de construcción y demolición.* (UHU)

Rosario, Y. (2005). *Impacto ambiental durante el proceso de la construcción.*

SCI. (2014). *Colapso del edificio space en medellín y la ingeniería estructural en colombia.* (Comisión de Estructuras de la SCI)

Sigler, M. (2014). The effects of plastic pollution on aquatic wildlife: Current situations and future solutions. *Water, Air, & Soil Pollution*, *225*(11).

Solarte, A. (2014). *El regimen de responsabilidad civil de los constructores en colombia.* (Fasecolda)

Sruti, P., Anju, E., Sunil, B., & Shrihari, S. (2014). Soil pollution near a municipal solid waste disposal site in india. In *International conference on biological, civil and environmental engineering (BCEE-2014) march 17-18, 2014 dubai (UAE)* (p. 148-152). International Institute of Chemical, Biological & Environmental Engineering.

UTP. (2017). *¿qué es la huella ecológica?* (Universidad Tecnológica de Pereira)

Vasquez, A. (2015). *Malas prácticas de la ingienería civil.*

Zuo, J., Rameezdeen, R., Hagger, M., Zhou, Z., & Ding, Z. (2017). Dust pollution control on construction sites: Awareness and self-responsibility of managers. *Journal of Cleaner Production*, *166*, 312-320.

ISSN 1692-8407

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

Tekhnê
July - December 2018, Vol. 15, No. 2, pp. 59 – 68

ISSN 1692-8407

Are GCR-modified asphalt roads the solution to the problem of road mesh in Bogotá (Colombia)?

¿Son las vías de asfalto modificado con GCR la solución para el problema de la malla vial en Bogotá (Colombia)?

Valentina Castellanos
Universidad Distrital Francisco José de Caldas
valentinaca1@hotmail.com

Nicolás Rodríguez
Universidad Distrital Francisco José de Caldas
rotinico_1@live.com

Karolyn Cárdena
Universidad Distrital Francisco José de Caldas
karolyn130@gmail.com

In synthesis, this article consists of a brief investigation about the mixture of GCR (Recycled Rubber Granule) with asphalt as a new alternative for the solution of the problem of the road mesh in Colombia, especially in the capital of the country. The research emphasizes the origin of its components, the processes that must be carried out to obtain such mixture, among other important aspects of it.

Keywords: Asphalt, Bogota, Environment, GCR, road problem, roads, rubber, tires

En síntesis, este artículo consiste de una breve investigación acerca de la mezcla de GCR (Granulo de Caucho Reciclado) con asfalto como una nueva alternativa para la solución al problema de la malla vial en Colombia, especialmente en la capital del país. La investigación hace énfasis en el origen de sus componentes, los procesos que se deben llevar a cargo para conseguir dicha mezcla, entre otros aspectos importantes del mismo.

Palabras clave: Ambiente, asfalto, Bogotá, caucho, GCR, llantas, problema vial, vías

Article typology: Research

Date manuscript received: December 7, 2017
Date manuscript acceptance: April 13, 2018

Research funded by: Universidad Distrital Francisco José de Caldas (Colombia).

How to cite: Castellanos, V., Rodríguez, N., Cárdena, K. (2018). *Are GCR-modified asphalt roads the solution to the problem of road mesh in Bogotá (Colombia)?*. Tekhnê, 15(2), 59 -68.

Introduction

We propose to expose the problems that have afflicted the capital city for a long time, the road network and its poor condition, and the disposal of used tires (Mancini, Nicosia, Luciano, Viotti, & Fino, 2017). In the first place, it is well known that the great number of holes in the main roads of Bogota cause daily quite heavy traffic and on the other hand the piles of tires that can be seen in many public places of Bogota (Colombia). And not only this, the burning of them causes very serious environmental damage. A joint solution to these two problems has been found, thanks to the asphalt mixture known as GCR (Recycled Rubber Grain), resulting from the mixing of asphalt with crushed tires (Boston, Leshchinsky, Kemp, & Wortman, 2017; Sulaeman, Hamdan, & Bin, 2016). With this mix, much more resistant and durable roads can be built, which would solve the problem of the road network in the capital, and would be giving an adequate use to the tires that are discarded daily in the city (Behnood & Olek, 2017; Sunil, Sahithi, Reshma, & Hemanth Raja, 2017).

Introduction to GCR

Used tires

With the great fire that occurred in a warehouse in Fontibón, with more than 600,000 tires accumulated, the contamination of the sector exceeded five times the maximum stipulated by the World Health Organization (WHO). The burning of tires disintegrates the rubber releasing carbon monoxide and dioxide, sulfur dioxide, which in the atmosphere can be converted into acid rain.

Because of all the environmental damage caused by tire burning, the District Secretary of the Environment asked the National Environmental Licensing Authority to plan a meeting to decide what should be done about it, to make plans for both the recycling and management of used tires in Bogotá.

Recycling tires

When discarded, the tires that have completed their cycle, visually contaminate, threaten public health by being buried, stored, or destroyed by incineration, and generate danger by being a generator of fires. Direct burning emits gases with harmful particles to the environment. Furthermore, storage not only implies a loss of space, resources, and energy, but also spaces that allow the proliferation of rodents and insects, especially mosquitoes that transmit dengue fever, yellow fever, and equine encephalitis. Likewise, in sanitary landfills, tires prevent waste compaction and generate instability due to the partial chemical degradation they suffer, since they take more than 100 years to degrade. The world has become aware of the importance of collecting and classifying waste for recycling. Such is the importance of this type of practice that some countries have taken initiatives that end up being reflected, in-laws. In Colombia, a great part of the tires is stored in clandestine deposits, roofs, house yards, lakes, rivers, and streets. Also, used tires increase the difficulties of open-air dumps, and the country's municipalities with waste disposal: Doña Juana in Bogotá, Don Matías in Medellín, and Navarra in Cali. In Bogotá alone, the Institute of Urban Development (IDU), points out that on average 18,861 tons of tires are generated per year, of which 71.9% have energy use (as fuel in the panela production ovens in the northwest of Cundinamarca), 17.2% are retreaded, 6.2% is used for handicrafts, 2.3% are used for re-grinding and the rest are used for other purposes. Faced with the public threat, the Technical Administrative Department of the Environment DAMA, as the competent entity within the urban perimeter of the City of Bogotá, since 2000 has begun schemes to address the problems generated by used tires.

Due to the above and the need to assign it to use that reduces the environmental impact generated by the bad disposal of used tires. There are different uses for used tires in Bogotá, but we will focus mainly on asphalt modified with recycled rubber grain (GCR) (Martínez & Martínez, 2012).

In addition to acting to solve the environmental impact caused by the disposal of tires in Bogotá, the feasibility of using used tires to improve the road network in the capital has been studied, since it is well known that traffic in the capital city is a total disaster and one of the many factors that influence this is the holes that fill the asphalt of the capital. Approximately 90% of the road network in Bogotá is in terrible condition, according to a report by the Comptroller's Office. According to the IDU, Bogotá has nearly 16,000 km of roads, 19% of which need to be repaired, and 43% of which require total intervention. The answer to the reason for this situation is that the constant growth in the acquisition of automobiles by citizens has contributed to the deterioration of the roads, since, principally, the roads in Bogotá were not designed to support so much weight. In addition to this, heavy-duty vehicles further worsen the condition of the roads in a more notorious way.

The GCR

The GCR is a possible innovative alternative to the asphalt mix that is so much in a state of deterioration. Not only does it influence the stability level for the construction of roads, but also the use of it is environmentally friendly.

The GCR (recycled rubber grain) modified asphalt is a binder formed by water and carbon or simply a hydrocarbon binder, product of the mixture of asphalt cement, recycled rubber grain (rubber particles obtained from a process of heating the rubber of the tire with sulfur to obtain a more resistant product) and some other indispensable additives for the use of the binder in pavement works.

ISSN 1692-8407

This alternative arises to stop the misuse of tires or wheels, which have lost value, at the economic level and use of it (Salamanca, 2007). Since these tires have a destiny not very controlled environmentally like: sanitary landfills, thermal plants, open-air garbage dumps, among others, that generate important environmental damage. At the same time, GCR is a product with high resistance to short-term deformation, effective in containing heavy traffic in our capital.

The use of it as an asphalt modifying agent allows an effective mix for the road mesh in Bogotá DC (Salamanca, 2007). This mixture is a binder formed by water and carbon, which provides resistance while allowing the use of additives to modify the qualities, capacities, and characteristics of the asphalt according to the interest of the project needs.

Due to the different studies that have been carried out, it has been determined that the asphalt modified with recycled rubber grain is a much more resistant, elastic, and durable mixture than the traditional mixtures that are frequently used in the capital. These characteristics already mentioned benefit Bogotá's road network, since, thanks to its high resistance, the roads are in better condition; its elasticity will provide a better reaction to the weight that must support the roads of a capital where the number of cars increases exponentially reducing a large number of holes and improving traffic and mobility in Bogota and its durability will save us the constant closure of roads for maintenance, which also causes unbearable road congestion for the large number of citizens who move through the city daily.

Although its satisfactory response as a binder in the asphalt mix is notorious at first sight, the Chamber of Commerce provides a graphic representation of the great difference between a road built with the recycled rubber grain asphalt mix (Fig. 1) and the traditional mix (Fig. 2).

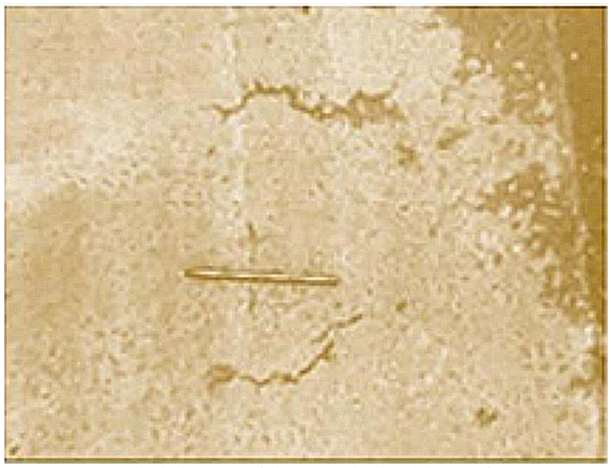


Figure 1. Asphalt layer with recycled rubber mix.

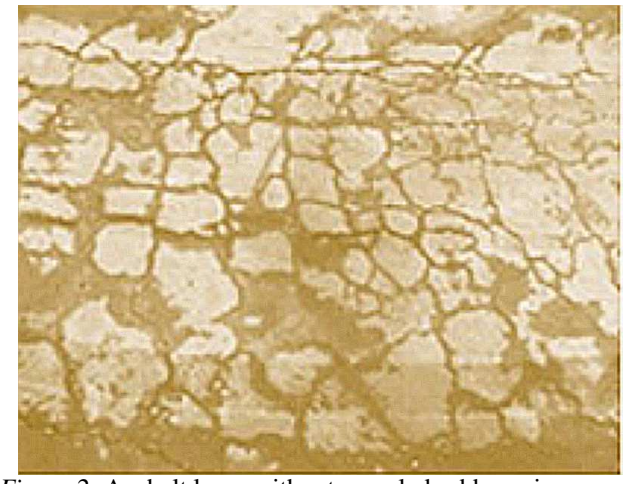


Figure 2. Asphalt layer without recycled rubber mix.

Obtaining the rubber grain

The recycled rubber grain can be obtained in different processes such as (INVIAS, 2010):

- Recapping.
- Room temperature grinding.
- Cryogenic grinding.

These three processes with increasing cost in the order in which they have been exposed, represent different alternatives of obtaining rubber grains, having each one of their characteristics. In Mexico, Colombia, Chile, and Peru a high use of GCR has been observed coming from the processes of recapping or retreading, whereby mechanical means, such as grinders or wearers, GCR is obtained without further contamination. It is then ground at room temperature and granulometric ranging from millimeters to 10 millimeters is obtained.

Process of elaboration of the GCR-modified asphalt

Dry process. As for the mixing, mixtures are made with fine aggregate. It generally acts as an aggregate, with the particularity that given its low weight per unit of volume it is essential to make a volumetric assessment since the contributions over GCR can produce segregation, losses by excessive abrasion, and higher contents of voids (Fig. 3) (Ramirez, 2008).

Wet process. Dispersers, or emulsion-type plant colloid mills, generate a more homogeneous dispersion, stable over time, with the rejuvenated GCR becoming wetted with the oily fraction of the binder. The strong cutting energy delivered allows the generation of adequate flow for dispersion (Fig. 4) (Villamizar, 2016).

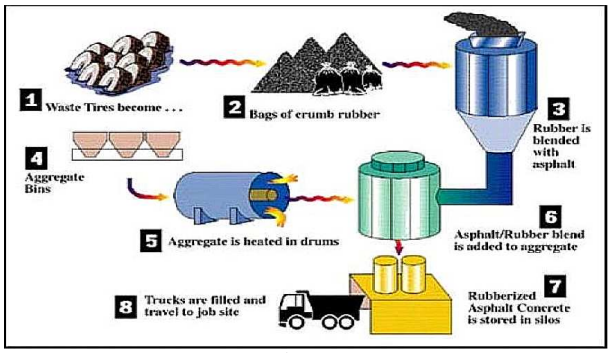


Figure 3. Dry process (Ramirez, 2008).

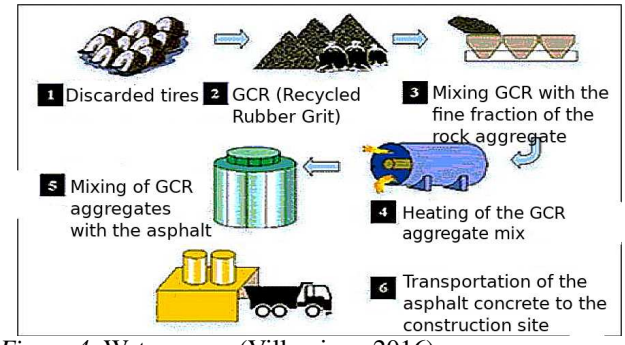


Figure 4. Wet process (Villamizar, 2016).

Properties and composition

Physical properties. It is a semi-solid bituminous product at room temperature, prepared from natural hydrocarbons through a process of purification and separation of its components, or distillation, which contains a very low proportion of products that change easily and unpredictably (volatile), has binding or mouldable, and resistant properties, and is essentially soluble in trichloroethylene. This is a visco-elastic-plastic material, which means that its behavior is directly related to the temperature and frequency with which it is charged, with recoverable (elastic) and non-recoverable (plastic) deformations (Díaz & Castro, 2017).

It is a plastic substance that gives great controllable flexibility to the aggregate mixtures (union of materials with different sizes) with which it is combined. Its color is lead (dark gray), of solid, semi-solid, or liquid consistency, depending on the temperature to which it is exposed.

Chemical composition. To guarantee a good performance in paving, it is important to know the chemical composition of the asphalt to control the physical properties. The chemical composition of asphalt is very complex, like crude oil, it is a mixture of numerous hydrocarbons, paraninic, aromatic, and heterocyclic compounds. The hydrocarbons that are part of the asphalt form a liquid solution in which a group of heavy hydrocarbon molecules (asphaltenes) are dispersed in a lighter oily medium (maltenes) composed of saturated hydrocarbons, resins, and aromatics, with no separation between these two phases but rather a transition (Díaz & Castro, 2017). When the assault is dissolved in n-heptane, the hard materials are precipitated, these materials are called asphaltenes, a name proposed by Boussingault in 1837. There are other asphalt fractions precipitated by other solvents, but this is the best way to distinguish these materials as insoluble in pentane.

Introduction of asphalt mixing with GCR in Bogotá

The accumulation of used tires is not a problem that discriminates against our country and especially against the capital of the republic. The magnitude of this problem can be seen by observing tires in pairs on-road spacers, parks, gardens, sidewalks, etc.

In the city of Bogotá, an average of 2.5 million used tires are generated annually, and it is estimated that 30% of these are thrown into public space. The illegal disposal of used tires negatively impacts the quality of life of people, because they deteriorate the landscape, cause fires, and the proliferation of mosquitoes and rodents.

A great example, of the immense danger that can lead to the precarious treatment that can be given to these tires, can trigger a fire, like the one of November 5, 2014, in a warehouse, located in the race 123 with street 14 c, which consumed about 600,000 tires. On this date, the District Secretary of the Environment declared an orange alert in six locations in Bogotá, creating chaos and concern about the exaggerated levels of gases that were released that day. Also, the warehouse, where the fire occurred, had been operating illegally since 2013 and was prohibited from storing tires, bringing to light the lack of control by the competent authorities over this problem.

These large fires generate dangerous acid rain, which in concept is any form of precipitation that presents high concentrations of sulfuric and nitric acid (National Geographic, 2010). It can also show up as snow, fog, and dry material particles that land on the earth. Decaying topsoil and erupting volcanoes release some chemicals into the atmosphere that can cause acid rain, but most of this precipitation is the result of human action. The biggest culprit in this phenomenon is the burning of fossil fuels from coal-fired power plants, factories, and car exhausts.

When humans burn fossil fuels, they release sulfur dioxide (SO2) and nitrogen oxides (NOx) into the atmosphere. These chemical gases react with water, oxygen, and other substances to form dilute solutions of nitric and sulfuric acid. Winds blow these acidic solutions into the atmosphere over hundreds of kilometers. When acid rain reaches the Earth, it flows across the surface, mixing with the wastewater and entering aquifers and farmland.

ISSN 1692-8407

Acid rain has many harmful consequences for the environment, but without a doubt, the most insidious effect is on lakes, rivers, streams, swamps, and other water environments. Acid rain raises the acidic level in aquifers, which allows aluminum to be absorbed and transferred from farmland to lakes and rivers. This combination increases the toxicity of the waters for crayfish, mussels, fish, and other aquatic animals.

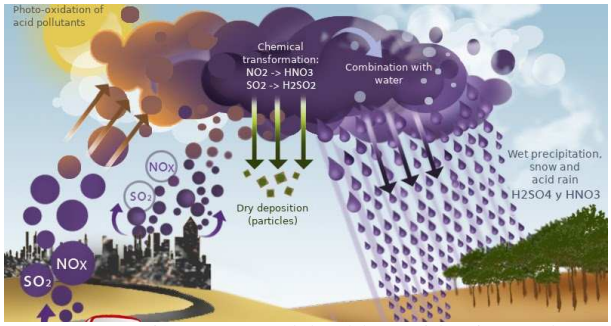


Figure 5. Environment and health: acid rain (Unknown, 2016).

Already demonstrated the risks of used tires, there is a program of post-consumption of these wastes in Bogotá, in this program, there is a very viable and optimistic solution to allocate these solid wastes, is the recycling of them, and the industrial production of GCR that as previously reiterated can be used as an additive for asphalt, creating a mixture with many advantages to address as:

- Less reflection of cracks.
- Decreases thermal susceptibility.
- Increases internal cohesion.
- Improves flexibility and elasticity.
- Improves fatigue behaviour.
- Increases the arid-binder adhesiveness.
- Greater durability and less maintenance.
- Environmentally friendly due to final disposal of disused tires.
- Reduction of layer thickness.

These advantages allow us to try to solve another problem of our city, which is the deterioration of the road network. According to the database of the IDU (Institute of Human Development) the road infrastructure of the city is in precarious conditions (Figs. 6, 7 and 8).

According to the District Planning Secretary, the road reserve zones are the strips of land necessary for the construction or expansion of public roads, which must be taken into account when carrying out processes of property allocation or the acquisition of real estate and in the construction of home public service networks (POT, 2004). We can conclude that the state of the arterial road network by 2013 was relatively good.

According to the District Planning Secretary, the intermediate road mesh is made up of a series of road

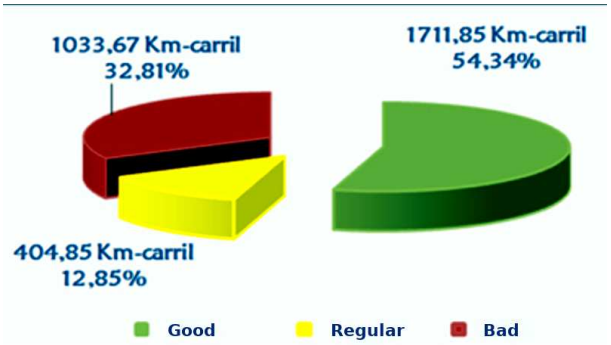


Figure 6. State of arterial road network 2013 (IDU, 2013).

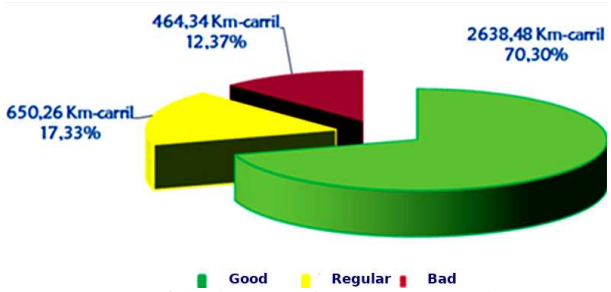


Figure 7. State of the intermediate road network 2013 (IDU, 2013).

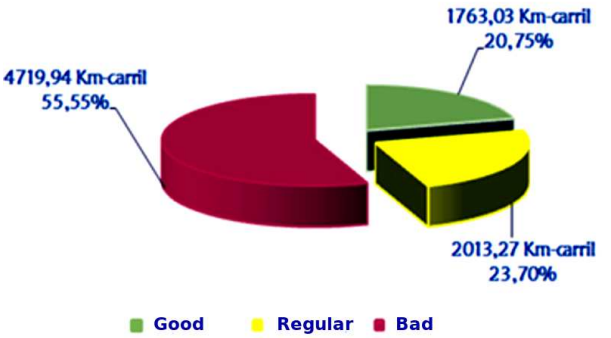


Figure 8. State of the local road network 2013 (IDU, 2013).

sections that permeate the grid that makes up the main and complementary arterial meshes, serving as an alternative for circulation to these. It allows access and fluidity of the city on a zonal scale (POT, 2004). In comparison to the above, we can see that the intermediate road mesh of 2013 is much better.

According to the District Planning Secretary, the local road network is made up of road sections whose main function is to allow accessibility to housing units (POT, 2004). As for the state of the local road network of 2013 is evident that compared to the arterial road network and the intermediate road network is in worse condition.

Why the rupture of the road network in Bogotá?

In our city, there is a belief that the deterioration of the streets of the capital is due to the bad conditions of the soil of the savannah, but according to engineers and experts in the field, ensure that these problems are minor and with modern technology and engineering are almost negligible, then the deterioration of the roads in the capital may be by over-saturation of vehicles and traffic in the city. The latest technology in asphalt, such as GCR, shows promise in combating the gaps in the city with quality roads designed based on this innovative product. Because in laboratories it has a great advantage over common asphalts.

Thanks to its greater plasticity this mixture shows excellent results against plastic deformation (Fig. 9), we conclude how hopeful this product can be when facing face to face the gaps in the capital of the republic.

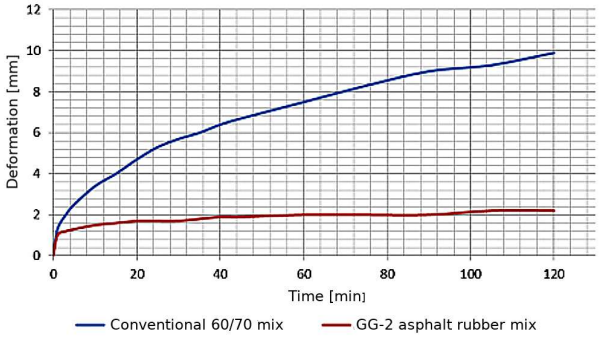


Figure 9. Resistance to plastic deformation through laboratory test track INV-756-07.

Advantages and disadvantages of GCR in Colombia

As a starting point for this topic, it is worth mentioning some of the Latin American countries in which GCR, as a new alternative infusion with the pavement, has left a great effect on society and the construction environment. It allows a new solution for these countries, both environmentally and in terms of mobility.

In Argentina, there are experiences in the city of Buenos Aires, through AUSA, in the city of La Plata, through the Municipality, in Santa Fe, Chaco, Neuquén, and in the Province of Buenos Aires, with fissure sealing works and hot asphalt concrete (Vargas & Rodríguez, 2014). In Mexico, Brazil, Costa Rica, Colombia, Chile, Peru, and Ecuador, we have participated in the use of these technologies with more than encouraging results from mechanical behavior, durability, economy, and less environmental impact.

The incorporation of rubber in road works in different regions of Latin America has allowed the design of products and mixtures with an adequate level of performance. The reduction of landfills for used tires can be substantially reduced.

In Argentina, there is a Program for the Recycling of Materials in Road Works (PROCQMA) of the SCYT of the UTN with 15 research centers that promote the execution of technical specifications and ordinances for this purpose.

The Recycled Rubber Grain - GCR, has a variety of uses such as in the manufacture of auto parts, carpets, synthetic grass, athletic tracks, soccer fields, playgrounds, sports centers, building entrances, horse tracks, riding schools, insulating bands, toys, shoe soles, mixed with asphalt for roads (modified asphalt).

The use of the tire is used as a raw material for the production of asphalt pavement or modified asphalt with rubber grain of asphalt pavement. Recycling - GCR, with recognized success in countries such as Canada, the United States, and all of Europe, among others, based on the addition of pulverized rubber (20 mesh/30 mesh) during manufacturing.

Advantages of GCR in Colombia. As we know, the problem of mobility in Colombia is not only influenced by the exponential growth at the population level that the country has had in recent years, but also as a root of this problem is the paving material which has looked to a new horizon by opting for the GCR as an element that benefits the resistance of the road network in Colombia (Fig. 10).

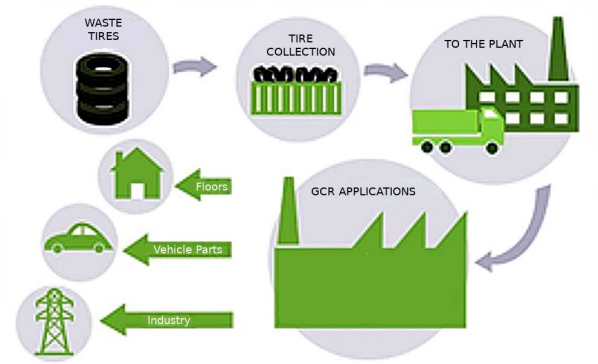


Figure 10. Tire diagram.

The recycled rubber grain in the asphalt cement acts as an aging inhibitor, prolonging its cohesive capacity over time (Díaz & Castro, 2017).

The mixture when modified becomes more flexible at low temperatures and at high temperatures it becomes less plastic. Carbon black from GCR prevents wear from tire-pavement friction, reinforces the asphalt, and reduces oxidation and aging. GCR provides flexibility and improves thermal susceptibility, as well as mechanical properties.

Disadvantages of GCR in Colombia.

- The cost of manufacturing this type of mixture exceeds that of conventional and modified mixtures.
- The manufacturing process of the mix has an impact on higher costs due to the increase in the amount of asphalt

ISSN 1692-8407

cement required, as well as the increase in compaction times on site.

- The wet modification process requires additional equipment and the replacement of pumps and pipes, as well as an increase in energy to heat the mix with longer mixing times.
- The absorption of oils from the asphalt by the GCR negatively affects the cohesive and adhesive properties of the binder, turning the mix into a dry mix.

Recycled rubber granule in Bogotá

Discarded tires in Bogotá

The population of Bogota has been in constant trouble, in terms of the disuse of car tires, not including that of bicycles. This situation is out of their hands because of the great pollution it generates.

The illegal dumping of tires pollutes ravines, forests, deserts, and vacant lots that led many passes to pass tire disposal regulations that require proper management. Unfortunately, tire storage and recycling are sometimes linked to illegal activities and lack of environmental awareness (Ecología Hoy, 2016).

Many of these also end up in collective wastelands or garbage dumps and cause great pollution because they are very resistant and their highly toxic components are not quickly degraded. For this reason, the objective of recycling them is a good initiative to find a suitable place to place them.

As mentioned earlier in this article, with the exponential increase in the number of disused tires in the capital it has become evident that over time tires as waste are taking over public spaces, affecting the city environmentally and visually. This problem reaches such a point that it is representing a sanitary concern since the piling up of these tires generates the arrival of mosquitoes and rats, the main carriers of diseases and infections, generating illnesses for the citizens who are close to these environments. This problem affects all regions of the country, clearly not in the same way (table 1).

Table 1
Table of data for regions (MinAmbiente, 2007).

Region	Percentage	Tire Tons
Cundinamarca	28.22%	53.760
Antioquia	18.31%	34.881
Eje Cafetero	6.78%	12.916
Costa Atlántica	13.72%	26.137
Valle	17.27%	32.900
Otras Regiones	15.70%	29.909

As can be evidenced in the exposed image no region of the country is saved from the *invasion* of the disused tires, being Cundinamarca the region mainly affected. Because this article deals with the solution to the problem of the road network in Bogotá, we will focus more on the values and statistics of this one (table 2).

Table 2
Data table for vehicles (MinAmbiente, 2007).

TIPO DE VEHÍCULO	A	B	C
			A x B
PARTICULAR (91%)	Número de vehículos	Llantas / Vehículo[1]	Total llantas en uso
Automóvil R–13	637,637	4	2,550,548
Automóvil R–14	63,063	4	252,252
Camión	18,200	6	109,200
Camioneta	81,900	4	327,600
Campero	72,800	4	291,200
Motos	36,400	2	72,800
SUB – TOTAL	*910,000*		*3,603,600*
PÚBLICO (9%)	Número	Llantas / Vehículo	Total llantas en uso
Taxi R–13	49,959	4	199,836
Taxi R–14	4,941	4	19,764
Bus	11,700	6	70,200
Buseta	9,900	4	39,600
Camioneta	5,400	4	21,600
Campero	3,600	4	14,400
Microbus / Colectivo	4,500	4	18,000
SUB – TOTAL	*90,000*		*383,400*
TOTAL	**1,000,000**		**3,987,000**

The table shows in more detail the number of tires in use in Bogotá, this total value of tires in use could mean the number of tires discarded in the capital in the future. Recycling helps to reduce the number of tires in storage that generate all these problems.

Used tire post consumer program

Used tires are not considered hazardous waste in Colombia, however, they need to be returned to producers to encourage recycling, use as asphalt aggregate or retread, and avoid being burned in open spaces and as fuel in informal activities (MinAmbiente, 2017).

Appropriate sites. Facilities belonging to used tire collection systems must comply with technical and safety requirements to ensure that the waste is handled safely and appropriately.

- They have fire safety measures.
- They store tires in an orderly manner, in covered places (not outdoors).

• They have visible advertising and documentation that allude to the systems and they are responsible.

Inappropriate sites. Unauthorized tire collection sites or persons can be identified primarily because:

• They pile up the tires in uncovered places.
• They do not have fire safety measures.
• They do not have advertising or material alluding to the Selective Collection System.

Since it is not easy for a consumer to know which companies or containers belong to a selective collection system, it is recommended to visit the link of systems presented before taking used tires somewhere.

How are used tires delivered?

To deliver the used tires must be taken into account:

1. Once the tires must be replaced, or you have any in your possession that must be discarded, check within the list of systems presented and according to the trademark or trusted supplier, an establishment that has an authorized collection point.

2. Once on-site, hand over the used tire or allow a technician, operator, or employee to take it to the storage site located inside the establishment.

GCR in Bogotá

In the manufacturing process, 100% of the tires are not used (Fig. 11).

Gross weight of a used truck tire	50.0 kg
20% steel	10.0 kg
6% nylon fibers	3.0 kg
Rubber that can be reused	37.0 kg
Gross weight of a used car tire	7.0 kg
7% steel	0.5 kg
10% nylon fibers	0.7 kg
Rubber that can be reused	5.8 kg

Figure 11. Industrial tire grinding process data.

According to 2014 records of the use of the asphalt mix made by Incoasfaltos, 800 tons of mix manufactured by this company were produced during 7 months, the product was used for the construction of important roads in Bogota, in this process, approximately 7200 used tires were recycled.

With the 800 tons of GCR manufactured, 5300 m^3 of compact asphalt mixes have been produced, with which the rehabilitation of 16.5 km/lane on the roads of towns such as Fontibón and Puente Aranda in the city of Bogotá has been achieved.

In the image, you can see the final product, which will be the object of studies to analyze the viability of its use and how good it is compared to the traditionally used mixture.

On the other hand, projects have been presented for the care and repair of the road network in Bogota and the rest of the country, with which the president of the National Agency of Infrastructure (ANI), Luis Fernando Andrade says that the rubber pavement of recycled tires has the advantage that it is more durable (less need to be repaved) and gives better traction for the tires. Even though the mixture is more expensive, it is a better long-term investment, because the pavements last longer. Well, as Andrade said, we would have before our eyes the possible solution to one of the main problems that beset the capital, which is the deplorable state of the road network in Bogota, and the large number of tires that are occupying public spaces in the capital.

At least 400,000 of the many millions of used tires are expected to be an asphalt manufacturing component.

GCR recycling plant in Bogotá

The big beneficiaries of the GCR in Bogotá are low-income people, honest people, the environment, the cities (Reciclair, 2017).

Making use of technological means not only for the search and collection of tires but also to change the habit of citizens implemented information where you can make the disposal of such waste since ultimately people throw them away because they are not informed of where or what they should do with these tires.

Consequently, used tire recycling plants will be generated around the capital. To minimize environmental pollution and the misuse of these tires. Currently, the most recognized used tire recycling plant is located in Mosquera (Cundinamarca). We are talking about the used tire recycling plant called Reciclair.

Regulations

Urban Development Institute (IDU). Resolution 3649 of September 16, 2009, issued by the Institute of Urban Development resolves in its Article Two to adopt the technical specification for the application of recycled rubber grain (GCR) in hot asphalt mixtures (wet process). The objective of this specification refers to the placement of the GCR in the asphalt mixtures as an asphalt modifying agent, this produces very good quality results if it is based on well-studied materials and correct design and construction methods. GCR may be the product of scraping vehicle tires in the retread process or slicing tires. The modification of the pure binder with GCR must be done with equipment that is capable of providing a homogeneous asphalt-rubber mixture.

The production of asphalt mix with a GCR-modified asphalt shall be equal to that stipulated for a

ISSN 1692-8407

polymer-modified asphalt, the mixing temperature of the aggregates and the asphalt-rubber shall be that which indicates the viscosity-temperature curve of the modified asphalt. Mix design shall be following 510.3 of Section 510.5 Dense, semi-dense, and thick hot mix asphalt. In Bogota, according to studies carried out by the IDU, through test sections using MDC-2 type asphalt mixtures and asphalt with low percentages of rubber, it was found that this improves the rigidity, resistance under monotonic load, to rutting, fatigue, aging, and decreases thermal susceptibility, this thanks to the fact that within its components are various types of polymers, such as Latex, SBS, SBR, and carbon black.

There are two techniques for using crushed tire grain (GCR) to modify the properties of asphalt mixtures, wet and dry. For the humid way, the dosage of the GCR is studied and for the design of the mixture, dynamic and volumetric criteria are used. In a dry way, the mixtures are designed by the Marshall method, considering as part of the design parameters such as the fatigue law, resistance to plastic deformation, and modules, the city has a specification for the application of recycled rubber grain (GCR) in hot asphalt mixtures (wet process), according to Resolution 3649 of September 16, 2009 (Instituto de Desarrollo Urbano 18 IDU and Alcaldía Mayor de Bogotá D.C., 2011).

According to the technical specification of the IDU, the GCR can be the product of scraping truck tires, or light vehicles in retreading processes or slicing tires, this should be uniform, free of metal, or other contaminants. (Institute of Urban Development IDU and Mayor's Office of Bogotá, 2011). It must be smaller than 595 μ. The following value ranges are recommended to modify the binder (tables 3 and 4).

Table 3
Specification of GCR-modified asphalts.

Caracteristica	UNIDAD	Norma de ensayo	minimo	maximo
Viscocidad Brookfield a163°C	Pa-s	ASTM D 4402/87	1.5	3
Penetracion a 25°C	0.1 mm	INV E 706	40	60
Punto de ablandamiento	°C	INV E 712	-	55
Pruebas al residuo despues de RTFOT				
Perdida de masa	%	INV E 720	-	1
Penetracion	%de la penetracion original	INV E 706	65	-
Recuperacion elastica	%		50	-

If at least one of the specified properties is not met, the optimal percentage of GCR for modifying a pure binder should be calculated through an experimental program following the recommendations. If the asphalt mixture is not used within the first 4 hours after the reaction time, it is reheated. This should be considered as one heating cycle, and the total number of heating cycles should not exceed two.

Table 4
Characteristic value range for modifying the binder with GCR.

VARIABLES	UNIDAD	MINIMO	MAXIMO
Cantidad de GCR	% sobre el peso del ligante	10	20
Tiempo de Reaccion	min	55	75
Velocidad de agitacion en laboratorio	min	100	750
Temperatura de mezclado	°C	155	170

As long as the mixture is kept at a high temperature, it should be kept in constant agitation, to avoid separation of the GCR and the asphalt cement.

The IDU together with the University of the Andes, developed research between the years 2001-2005, the objective of the research was to study the feasibility of the application, establish the benefits, and propose initial specifications. The corridor chosen by the IDU to carry out the project is located on carrera96, between 67A and 63 streets, better known as José Celestino Mutis Avenue. As for all road works, a complete characterization of the subgrade and the existing granular layers was carried out on the chosen corridor. Five types of mixtures with different binders were placed on the corridor, but with the same granulometry. Among the mixtures placed, two types of mixtures with commercial binders modified with polymers were included to serve as a comparison with the mixtures under study. Once the construction of the test track was completed, a year of monitoring and follow-up of the constructed sections began. Wet and dry processes were examined.

What does the law of the city of Bogotá say?. As of 2012, the Institute for Urban Development (IDU) has contractually incorporated an environmentally friendly technology, the recycled rubber grain (GCR), into the paving of Bogota's streets as an asphalt modifying agent within the hot asphalt mixtures used in the intervention of Bogota's road network; This decision is inspired by Resolutions 2397 and 6891 of 2011 of the District Secretary of Environment; the Territorial Ordering Plan that advocates for a sustainable, productive and high environmental quality urban ecosystem and the recommendations of the IDU's Technological Innovation and Clean Production Board. The new bidding documents establish that, from the study and design stage, the use of RAP should be included in no less than 10% of the total square meters and, at a minimum, 5% of GCR, that is to say, that the work contractors should use materials from the use of tires in a percentage of no less than 5% of square meters of the total of each work contract. The percentages will be increased annually by five points, until completing the 25% goal, as they are mandatory

percentages, whoever submits a proposal with them will not receive additional points.

Conclusions

In this article, we have tried to introduce the general public to an innovative and promising product, which may well be a short and long term alternative to face the deterioration of the road network in Bogotá. The GCR is a strong candidate for our city to finally have a high-quality road infrastructure, or at least not so susceptible to breakage and become almost anti-regulatory, the GCR, as has been reiterated is high-quality technology, and with the implementation that this article intends to give this product; If applied in a self-sustainable way, it would end up with a host of social, economic, environmental and mobility problems in the capital. This is due to the international background of cities that have put the GCR charter on the table of solutions, in conclusion, this alternative must be looked at by the district authorities with the highest seriousness of the case and to implement measures for an optimal application of the product at the district level, and finally to have a city without contamination by used tires, without fires by badly handling of these and with a road mesh according to the magnitude, and standards that this, our beautiful city deserves, and we deserve us the inhabitants of the city.

References

Behnood, A., & Olek, J. (2017). Stress-dependent behavior and rutting resistance of modified asphalt binders: An mscr approach. *Construction and Building Materials*, *157*, 635-646.

Boston, K., Leshchinsky, B., Kemp, E., & Wortman, R. (2017). The use of a rotary asphalt broom to groom aggregate forest roads. *Croatian Journal of Forest Engineering*, *38*(1), 119-126.

Díaz, C., & Castro, L. (2017). *Implementación del grano de caucho reciclado (gcr) proveniente de llantas usadas para mejorar las mezclas asfálticas y garantizar pavimentos sostenibles en bogotá.* (Universidad Santo Tomas)

Ecología Hoy. (2016). *Reciclado de neumáticos: Qué es y cuáles son sus beneficios.*

IDU. (2013). *Base de datos del inventario y diagnóstico de la malla vial.*

INVIAS. (2010). *Asfalto modificado con grano de caucho reciclado.*

Mancini, G., Nicosia, F., Luciano, A., Viotti, P., & Fino, D. (2017). An approach to an insular self-contained waste management system with the aim of maximizing recovery while limiting transportation costs. *Waste and Biomass Valorization*, *8*(5), 1617-1627.

Martínez, J., & Martínez, F. (2012). Optimization of maintenance management of trees in power distribution systems. *Tecnura*, *17*(35), 12-25.

MinAmbiente. (2007). *Gestión diferencial de llantas post-consumo.* (Ministerio de ambiente, vivienda y desarrollo territorial)

MinAmbiente. (2017). *Programa de pos consumo.*

National Geographic. (2010). *¿sabes qué es la lluvia ácida y de qué forma afecta al medio ambiente?*

POT. (2004). *Resultados de búsquedaresultados de la webplan de ordenamiento territorial.* (Decreto 190 2004, articulo 165)

Ramirez, F. (2008). *Sistemas de manufactura.*

Reciclair. (2017). *Planta de reciclaje de llantas - reciclair.*

Salamanca, G. (2007). *Influencia de la contaminación salina en el envejecimiento prematuro de mezclas y tratamientos asfálticos.*

Sulaeman, A., Hamdan, R., & Bin, M. (2016). Potential use of shredded tyre as a filter medium in subsurface drainage layer. *ARPN Journal of Engineering and Applied Sciences*, *11*(11), 7198-7203.

Sunil, K., Sahithi, K., Reshma, T., & Hemanth Raja, K. (2017). Use of industrial wastes in the construction of flexible pavements. *International Journal of Civil Engineering and Technology*, *8*(4), 1117-1122.

Unknown. (2016). *Lluvia ácida.* (Ciencia al Descubierto)

Vargas, N., & Rodríguez, F. (2014). *Diagnóstico de las condiciones superficiales y evaluación del comportamiento estructural del pavimento de las vias construidas por el instituto de desarrollo urbano con asfalto modificado con caucho recilado de llanta (gcr), en las localidades de fontibón, bosa y teusaquillo, en la ciudad de bogotá.* (Universidad Militar Nueva Granada)

Villamizar, J. (2016). *Estudio de prefactibilidad tecnica y financiera para la creacion de una empresa dedicada a la produccion de mezcla asfaltica 60 –70 con gcr(goma de caucho reciclado).* (Universidad Industrial de Santander)

Instrucciones para los autores

Tekhnê
Tecnología al servicio de la sociedad
Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Revista Tekhnê
Universidad Distrital Francisco José de Caldas
Facultad Tecnológica

Alcance y política editorial de la revista

La revista **Tekhnê** es una revista institucional de la Facultad Tecnológica de la Universidad Distrital Francisco José de Caldas (Colombia). Es arbitrada, y acepta trabajos originales en el campo de la ingeniería, la tecnología y las ciencias aplicadas, con la condición de que sean producto de trabajos de investigación. Desde su primer número en el año 2003, la revista ha mantenido su regularidad.

Posee un carácter científico-académico, y atiende a la comunidad nacional e internacional especialista en áreas de ingenierías eléctrica, electrónica, mecánica, de sistemas, industrial y civil. Publica resultados de investigación en inglés (artículos originales e inéditos), y está completamente abierta a especialistas de todo el mundo en calidad de autores y/o lectores. Es arbitrada mediante un proceso doble ciego, con rotación continua de árbitros.

La revista **Tekhnê** posee una periodicidad semestral, coincidente con los semestres académicos de la Universidad Distrital. La publicación se realiza los meses de junio y diciembre de cada año. El proceso de evaluación de los trabajos sometidos para la publicación contempla una etapa de aceptación inicial por parte del Comité Editorial, quien verifica el cumplimiento de los parámetros editoriales, y una evaluación por pares académicos mediante un proceso doble ciego. El tiempo que toma decidir sobre la aceptación de un trabajo nunca supera los seis (6) meses a partir de la fecha de recepción.

La revista **Tekhnê** está comprometida con altos estándares de ética y toma las medidas posibles para evitar las malas prácticas como el fraude y el plagio. Todos los autores deben declarar que sus manuscritos son originales, inéditos y de su autoría, condición necesaria para ser considerados por el Comité Editorial. La revista **Tekhnê** también se compromete a garantizar una justa, objetiva y rápida revisión de los manuscritos tanto por árbitros como por parte del Editor. Los autores reconocen que han dado a conocer cualquier conflicto real o potencial de intereses con su trabajo o de beneficios parciales asociados a través de la cesión de derechos.

La revista **Tekhnê** es financiada por la Universidad Distrital Francisco José de Caldas, razón por la cual NO cobra por procesamiento y/o publicación de artículos (APCs).

Tipos de artículos aceptados

La revista publica exclusivamente artículos de Investigación Científica y Tecnológica (según clasificación del Índice Nacional de Publicaciones Científicas y Tecnológicas Publindex de Colciencias), los cuales se caracterizan por presentar resultados originales de proyectos terminados de investigación, con secciones claramente diferenciadas de introducción, metodología, resultados y conclusiones. Otro tipo de artículos como los denominados de reflexión, revisión, artículos cortos o reportes de casos no son aceptados, y serán rechazados por el Comité Editorial sin surtir proceso alguno de evaluación.

Formato del manuscrito

En cuanto a estructura, deben ser evidentes las secciones de introducción, metodología, resultados, conclusiones y referencias. El resto del documento se debe conformar en concordancia con su contenido. La longitud no debe superar las 25 páginas en su totalidad. En la parte inicial de la primera página se debe incluir: (1) Un título del manuscrito (en español e inglés), corto, descriptivo del contenido y atractivo para el lector. (2) Nombre completo de los autores y detalles de afiliación institucional, incluido correo electrónico. (3) Resumen (en español e inglés) del manuscrito con un tamaño máximo de 250 palabras, que establezca el objetivo, la metodología, los resultados y principales conclusiones. (4) Palabras claves, máximo cinco, en minúsculas y separadas por comas.

En cuanto al formato de documento solicitado a los autores, se pide no utilizar estilos de los procesadores de textos. El manuscrito debe estar a una columna, a espacio sencillo entre líneas de texto y sin dejar espacio entre párrafos y entre títulos y texto. Se debe seleccionar papel tamaño carta (21 cm de ancho por 29.7 cm de largo), en forma vertical. Los márgenes deben ser 2 cm en todos los lados (izquierda, derecha, arriba y abajo). Se debe usar letra Times New Roman (si no se posee, utilizar una de tipo serif similar) sin reducción de espacio entre caracteres, con tamaño de 12 puntos. Por ningún motivo se aceptarán trabajos que incluyan letras, palabras o símbolos manuscritos en el texto. Las tablas y figuras deben ser claras y nítidas, insertadas (no pegadas) en el documento como un único objeto (no agrupación de varios) con la mayor calidad posible. Se pide que estas figuras sean remitidas en un archivo comprimido por separado. Si se usan líneas o figuras en colores, no se debe usar colores claros (amarillos, celestes y similares). El Editor se reserva el derecho de eliminar toda figura o tabla que no cumpla las normas. Toda figura, tabla, ecuación o referencia incluida en el manuscrito debe estar referenciada/citada en el cuerpo del documento. No se debe usar sangría en ninguna sección del artículo. Las referencias deben manejar correcto estilo APA sexta edición. No se deben utilizar notas al pie de página, y usar máximo tres niveles para los títulos. Se puede incluir una sección de Agradecimientos (altamente recomendada), redactada en forma sobria, de no más de cuatro líneas justo después de las Conclusiones.

En cuanto al formato del archivo fuente, se puede utilizar cualquier procesador de textos, siempre y cuando el contenido sea completo y editable (no se permite archivos *.txt). Los formatos recomendados son: *.rtf, *.doc, *.docx, *.odt, *.wpd y *.tex. En caso de utilizar LaTeX, se deben remitir todos los archivos fuente. Para todos los casos, los autores deben remitir, junto con las imágenes, un archivo BibTeX (un único archivo *.bib) con todas las referencias utilizadas en el artículo, cada referencia con una key única. Este archivo puede ser generado desde manejadores de referencias como Mendeley y Zotero, o generado con herramientas como JabRef.

En cuanto al lenguaje y estilo de redacción, se deben utilizar oraciones simples y evitar regionalismos. Se debe poner especial cuidado en el correcto uso de la ortografía y redacción, de acuerdo a las reglas del lenguaje.

Formato de publicación

Los manuscritos son publicados siguiendo el estilo APA sexta edición. Esto es realizado en la diagramación, y es transparente para los autores.

Cambios en la edición

El Editor se reserva el derecho, y así lo acepta el(la)(los) autor(a)(es) con el sólo envío del manuscrito, de realizar modificaciones con el objeto de lograr una mejor presentación e impacto del trabajo. Estas modificaciones pueden incluir cambios en el título, resumen, palabras clave, figuras, tablas y texto, entre otros, cambios que no afectan, según el Editor, la esencia del trabajo enviado por los autores. En particular, figuras que no pueden ser bien reproducidas pueden ser eliminadas por el Editor. Las referencias incompletas serán también eliminadas por exigencias de las bases de datos.

Envío de manuscritos

Los autores deben enviar sus artículos a través de la aplicación para tal fin del Open Journal System (http://revistas.udistrital.edu.co/ojs/index.php/tekhne/index) en formato digital, adjuntando:

- La carta de presentación.
- La carta de cesión de derechos (según formato).

La carta de presentación debe estar dirigida al director y editor de la revista, Ing. Fredy H. Martínez S., y debe incluir:

- Solicitud expresa de considerar el artículo para publicarlo en la revista **Tekhnê**.
- Título completo del trabajo.
- Nombres completos de todos los autores, con detalle de entidad a la que se encuentran vinculados, dirección e-mail institucional, títulos académicos, ciudad y país.
- Certificación de la originalidad y el carácter inédito del artículo.
- Exclusividad de su remisión a la revista **Tekhnê**.
- Confirmación de la autoría con la firma de todos los autores.
- Institución que financió o avaló el proyecto.

El proceso de envío consta de tres etapas:

1. Envío del artículo en formato PDF. Se carga al OJS un único archivo sin comprimir.
2. Registro de los datos. Se regista en el OJS los datos básicos de los autores y del artículo.
3. Envío de Archivos Complementarios. Todos los archivos complementarios se envían en un único archivo comprimido. Estos archivos complementarios incluyen: los archivos fuente del documento, tanto texto como imagenes en alta calidad, archivo BibTeX con todas las referencias utilizadas, la carta de presentación, y la carta de cesión de derechos.

Proceso de publicación

El proceso que sigue la revista para la evaluación y publicación de trabajos es el siguiente:

- Recepción del manuscrito (primera versión, convocatoria permanente)
- Verificación de normas por parte de auxiliar de la revista
- Notificación a autores de recepción, solicitud de ajustes de forma y de diligenciamiento de formato de datos de autores
- Recepción de manuscrito (segunda versión) y formato de datos de autores
- Revisión por parte del Comité Editorial
- Notificación a autores de si el manuscrito entra o no a evaluación por parte de pares
- Envío de manuscrito a pares seleccionados
- Recepción de evaluación de pares
- Notificación de evaluación a autores, y solicitud de correcciones si son pertinentes
- Recepción de manuscrito (tercera versión)
- Estudio de manuscrito corregido por parte del Comité Editorial
- Notificación a autores de decisión final de publicación y solicitud de carta de cesión de derechos
- Recepción de carta de cesión de derechos
- Corrección de estilo y diagramación del manuscrito
- Envío de versión final a autores para verificación de errores y aprobación final
- Publicación del artículo
- Notificación a autores de publicación
- Entrega de ejemplares a autores

Contacto

Para cualquier solicitud de información adicional puede comunicarse con:

Prof. Fredy H. Martínez S.
Editor y director revista Tekhnê
Sala de Revistas, Bloque 5, Oficina 301
Facultad Tecnológica
Universidad Distrital Francisco José de Caldas
Transversal 70B No. 73A-35 sur
Teléfono: (571) 3238400 Ext. 5003
Celular: (57) 3005585481
Bogotá D.C., Colombia
E-Mail: fhmartinezs@udistrital.edu.co
Url: http://revistas.udistrital.edu.co/ojs/index.php/tekhne/indexl

Instructions for authors

Tekhnê

Tecnología al servicio de la sociedad

Universidad Distrital Francisco José de Caldas - Facultad Tecnológica

Tekhnê Journal
Universidad Distrital Francisco José de Caldas
Facultad Tecnológica

Scope and editorial policy of the journal

The **Tekhnê** journal is an institutional journal of the Technological Faculty of District University Francisco José de Caldas (Colombia). It is arbitrated, and accepts original articles in the field of engineering, technology and applied sciences on the condition that they are the product of research work. Since its first issue in 2003 the journal has maintained its regularity.

It has a scientific-academic nature and attends the specialist national and international community in the areas of electrical, electronics, mechanical, systems, industrial and civil engineering. Publishes research results in English (original and unpublished articles), and is fully open to experts from around the world as authors and/or readers. It is arbitrated by a double-blind process, with continuous rotation of evaluators.

The **Tekhnê** journal has twice a year periodicity, coinciding with the academic semesters of the District University. The publication is made in June and December each year. The evaluation process of the papers submitted for publication includes a stage of initial acceptance by the Editorial Committee, which verifies compliance with the editorial parameters and an evaluation by academic peers through a double blind process. The time taken to decide on the acceptance of a paper never exceeds six (6) months from the date of receipt.

The **Tekhnê** journal is committed to high ethical standards and take possible measures to avoid bad practices such as fraud and plagiarism. All authors must declare that their manuscripts are original, unpublished and of his own, needed condition to be considered by the Editorial Committee. The **Tekhnê** journal also is committed to ensuring a fair, objective and quick review of manuscripts both referees as by the Editor. The authors recognize that they have disclosed any actual or potential conflict of interest with their work or partial benefits associated through the transfer of rights.

The **Tekhnê** journal is funded by the District University Francisco José de Caldas, which is why it does NOT charge for processing and/or publishing articles (APCs).

Types of articles accepted

The journal publishes only Scientific and Technological Research articles (as classified by Publindex, the National Abstracting and Indexing System for Serial Publications in Science, Technology and Innovation of Colciencias), which are characterized by original results of completed research projects with clearly distinct sections of introduction, methodology, results and conclusions. Other articles as called reflection, review, short articles or case reports are not accepted and will be rejected by the Editorial Committee without dispensing any evaluation process.

Manuscript format

Regarding the structure, should be evident the sections of introduction, methodology, results, conclusions and references. The rest of the document must conform in accordance with its contents. The length should not exceed 25 pages in full. In the initial part of the first page should include: (1) A manuscript title (in Spanish and English), short, descriptive of the content and attractive to the reader. (2) Full name of the authors and institutional affiliation details, including email. (3) Abstract (in Spanish and English) of the manuscript with a maximum size of 250 words, which set the objective, methodology, results and major conclusions. (4) Keywords, up to five, lowercase and separated by commas.

Regarding the document format requested, authors are asked not to use styles of word processors. The manuscript must be on a column, single space between lines of text without space between paragraphs and between titles and text. Must be selected letter size paper (21 cm wide by 29.7 cm long) vertically. Margins should be 2 cm on all sides (left, right, up and down). Must be used Times New Roman (if the font is not available, use a similar serif type) without reducing character spacing, of 12 points. No articles including letters, words or symbols handwritten in the text will be accepted. Tables and figures should be clear, inserted (not pasted) in the document as a single object (no grouping of several) with the highest possible quality. It is requested that these figures are sent in a separate zipped file. If lines or color figures are used, you should not to use light colors (yellow, light blue...). The Editor reserves the right to remove any figure or table that does not meet the standards. Every figure, table, equation or references in the manuscript should be referenced/cited in the document body. Should not be indented any section of the article. References should handle right APA format 6th Edition. Do not use footnotes, and maximum to use three levels for titles. You can include an Acknowledgments section (highly recommended), written soberly, of no more than four lines, right after the Conclusions.

Regarding the source file format, you can use any word processor, as long as the content is complete and editable (*.txt files are not allowed). Recommended formats are: *.rtf, *.doc, *.docx, *.odt, *.wpd y *.tex. When using LaTeX, the author must submit all source files. In all cases, the authors must submit, along with the images, a BibTeX file (a single *.bib file) with all references used, each reference with a single key. This file can be generated from reference managers like Mendeley and Zotero, or generated with tools such as JabRef.

Regarding the language and style of writing, the author must use simple sentences and avoid regionalisms. He must take special care to use the correct spelling and writing, according to the rules of language.

Publication format

The manuscripts are published following the APA style 6th edition. This is done in the layout, and is transparent to the authors.

Editing changes

The Editor reserves the right, and is accepted by the author(s) with the only article shipping, to make changes in order to achieve a better presentation and impact of the work. These modifications may include changes in the title, abstract, keywords, figures, tables and text, among others, changes that do not affect, according to the Editor, the essence of the work submitted by the authors. In particular, figures that can not be well reproduced can be eliminated by the Editor. Incomplete references will also be eliminated by demands of databases.

Sending manuscripts

Authors must submit their articles through the application for the purpose of the Open Journal System (http://revistas.udistrital.edu.co/ojs/index.php/tekhne/index) in digital format, attaching:

• The presentation letter.
• The transfer of rights letter (according to format).

The presentation letter should be addressed to the director and editor of the journal Prof. Fredy H. Martínez S., and it should include:

• Express request to consider the article for publication in **Tekhnê** journal.
• Full title of the article.
• Full names of all authors, detailing entity linked, institutional e-mail address, academic degrees, city and country.
• Certification of the originality and novelty of the article.
• Exclusivity of submission to **Tekhnê** journal.
• Confirmation of authorship with the signature of all authors.
• Institution financing the project.

The submission process consists of three stages:

1. Sending the article in PDF format. OJS is charged with a single uncompressed file.
2. Data recording. the basic data of the authors and article are registered in the OJS.
3. Complementary files. All additional files are sent in a single compressed file. These complementary files include: the source of the document, both text and images in high quality, BibTeX file with all references used, the presentation letter, and the transfer of rights letter.

Publishing process

The process followed by the journal for evaluation and publication of articles is as follows:

• Receipt of the manuscript (first version, continuously open call)
• Verification of standards by the assistant of the journal
• Notification to authors of receipt, request for the form adjustments and filling of authors data format
• Receipt of the manuscript (second version) and authors data format
• Review by the Editorial Committee
• Notification to authors if the manuscript is sent or not to evaluation by peers
• Sending the manuscript to selected peers
• Reception peer evaluation
• Notification of evaluation to authors, and request corrections if they are relevant
• Receipt of the manuscript (third version)
• Study of manuscript corrected by the Editorial Committee
• Notification to authors of publication and final decision, and request the rights transfer letter
• Reception of the rights transfer letter
• Style correction and layout of the manuscript
• Send final version to authors for error checking and final approval
• Publication of the article
• Notification to authors of the publication
• Delivery of copies to authors

Contact

For any request for additional information please contact:

Prof. Fredy H. Martínez S.
Editor and director Tekhnê Journal
Sala de Revistas, Bloque 5, Oficina 301
Facultad Tecnológica
Universidad Distrital Francisco José de Caldas
Transversal 70B No. 73A-35 sur
Phone: (571) 3238400 Ext. 5003
Cell phone: (57) 3005585481
Bogotá D.C., Colombia
E-Mail: fhmartinezs@udistrital.edu.co
Url: http://revistas.udistrital.edu.co/ojs/index.php/tekhne/index