EVALUATION OF THE "CARBON FOOTPRINT" (OF DIFFERENT FLUVIAL STRUCTURES)

Gerardo Fracassi Author, Eng.,[1] Carlos Enrique Moreno Martinez Author,[2]

[1]Maccaferri do Brasil Ltda., P.O. Box 520, Jundiaí, SP – Brasil; e-mail: fracassi@maccaferri.com.br
[2]Maccaferri de Colombia Ltda., Bogotá – Colombia; e-mail: carlos.moreno@maccaferri.com.co

ABSTRACT

The objective of the study was to define the carbon footprint of representative structures in Reno® gabions and mattresses and compare them with traditional construction techniques.

INTRODUCTION

The growing interest in climate change and its negative effects on the environment and on global economies, is forcing the most important organizations in the world to identify solutions that demonstrate to have a low impact in terms of GHG (Green House Gases emissions). The methodology chosen for the calculation of the carbon footprint is the "GHG Protocol Product Life Cycle Accounting and Reporting Standard", and all the activities that have been detected are related to the release of CO_2.

The gases considered in this document are those indicated in the United Nations Framework Convention on Climate Change (UNFCCC) and in the Kyoto Protocol. All the activities examined were related to the emission of CO_2, therefore the GHG of reference for the calculation was CO_2. Note that the GHG removed from the atmosphere was not considered, although the works where double twist solutions are used allow a rapid regeneration of the vegetation in the areas interested in the intervention.

In the project (Sauli 2014) the carbon footprint was calculated in two equivalent containment structures, a gravity containment wall in gabions, which was compared to an equivalent reinforced concrete wall (Fig. 1).

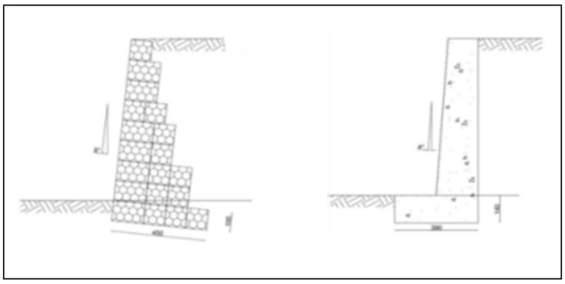

Figure 1. - Graphic representation of wall in gabions (left) and concrete (right)

the study was repeated in two coatings of equivalent margins, one existing in Reno® mattresses and the other in rip-rap (Fig. 2) that was only designed.

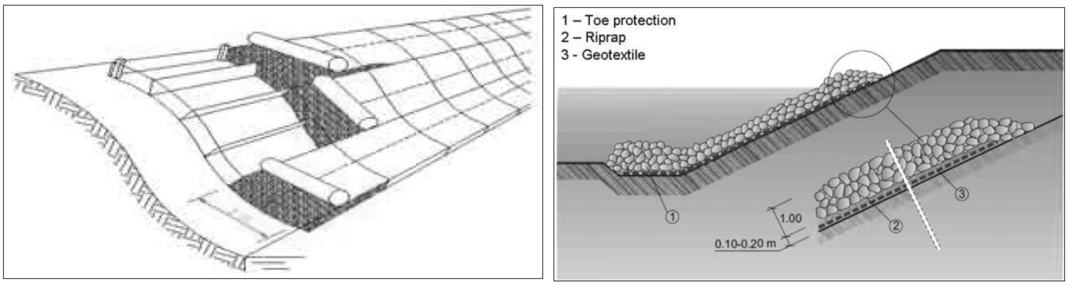

Figure 2 .- Graphic representation of Reno® mattress lining (left) and rip-rap (right)

<u>First study</u>: the considered gravity wall measures 10 m in length and 8 m in height (80 m^2 of external surface). The foundation of the wall is 4.5 m, with a transversal area of 22.5 m^2 for a total volume of 225 m^3. It was considered the use of gabions with specific weight of 9.5 kg/m^3 of 2 x 1 x 1 m, in mesh type 8x10, produced with wire of diameter 2.7 mm coated with Galfan alloy and covered with a PVC sheath of 0.05 mm thick, thus reaching the total thickness of 3.7 mm. For filling, stones with an apparent specific weight of 1,750 kg/m^3 were used, the total weight of the stones needed to fill the gabions was approx. 415 t (considering a 5% waste) and, for transporting them, two alternatives were considered, from a quarry less than 100 km from the workplace and a more distant quarry.

For comparison purposes, the traditional solution was considered: a concrete wall of class Rck 45, with an equivalent section of 18.9 m^2, not reinforced with steel (the shape allows the wall to be subjected only to compression stresses), dimensioned under the same terms. The total volume was 189 m^3 and the total weight was 465 t of concrete. The ready-mix concrete plant was considered at a distance of approx. 50 km from the workplace.

<u>Second study</u>: the structure analyzed is a real coating on Reno® mattresses, located on the river 'Tenore', a tributary of the Olona River in the province of Varese in northern Italy, which is part of a construction project for the 'Pedemontana' motorway Lombarda'. The coated surface is approximately 5,400 m^2 and elements of 4 x 2 x 0.30 m were used, in 6x8 type mesh produced with 2.2 mm diameter wire coated with Galfan alloy and covered with a 0.05 PVC sheath mm thick, thus reaching the total thickness of 3.2 mm. For the filling, 1,620 m^3 of stones from the local river were used. The analysis also considered the alternative of the use of quarry stones.

For comparison purposes, the traditional equivalent solution considered in this case was a lining of loose stones (rip-rap), of larger dimensions than those used for the filling of the Reno mattresses, of 1 m thickness (normally the relationship between the thickness of the lining on Reno® mattresses and rip-rap is 1: 3), with volume approx. of 5,670 m^3, transported from a quarry to approx. 100 km away and considering the 5% waste.

In the case of double torsion structures, the production process was divided into the macro phases illustrated in Fig. 3.

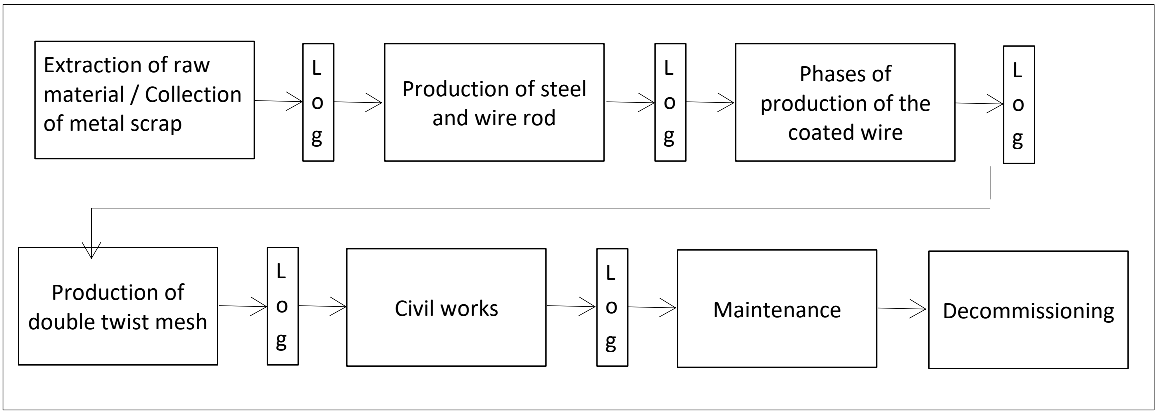

Figure 3. - Map of the production process of the gabion

Steel production was considered to originate in three Italian steelmakers and the production method considered was cast iron scrap, as it is the only type of steel used by Maccaferri in Italy since 2009.

Transport emissions were calculated on the basis of typical transport emission factors of the Sina network for heavy vehicles, while for normal routes a combination of 70% on motorways and 30% on urban roads was considered. All steel is transported to a production industry where the extraction and coating process is carried out in its entirety. The emissions in the factory, given the availability of primary data for the last three years, were calculated and related to the annual production.

The values found are related in Fig. 4 and Fig. 5 that consider different origins of the stones.

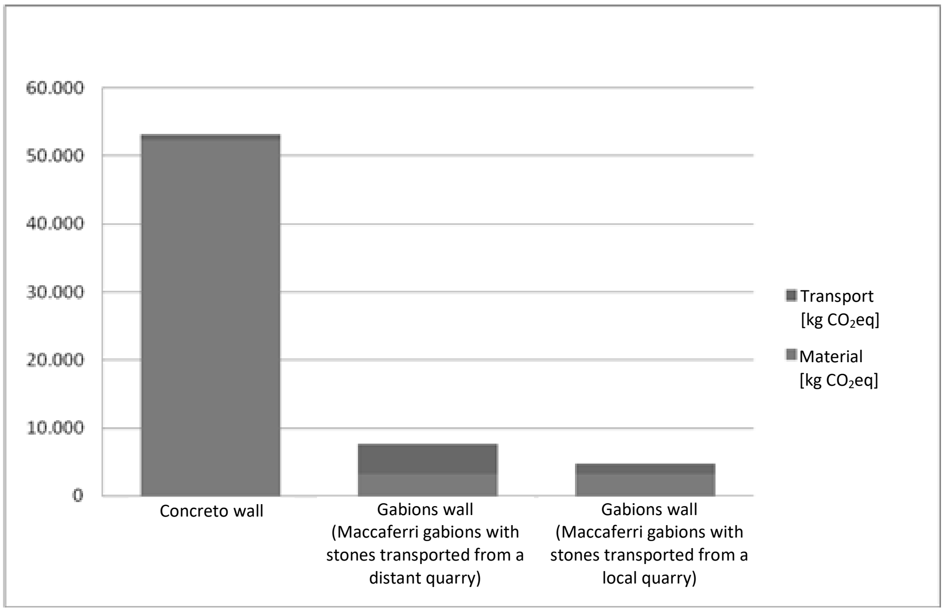

Figure 4. - Comparison between CO2 emissions related to the construction of a gravity wall: traditional solution (concrete wall) vs. wall of gabions (with stones from a distant quarry and gives a neighbor)

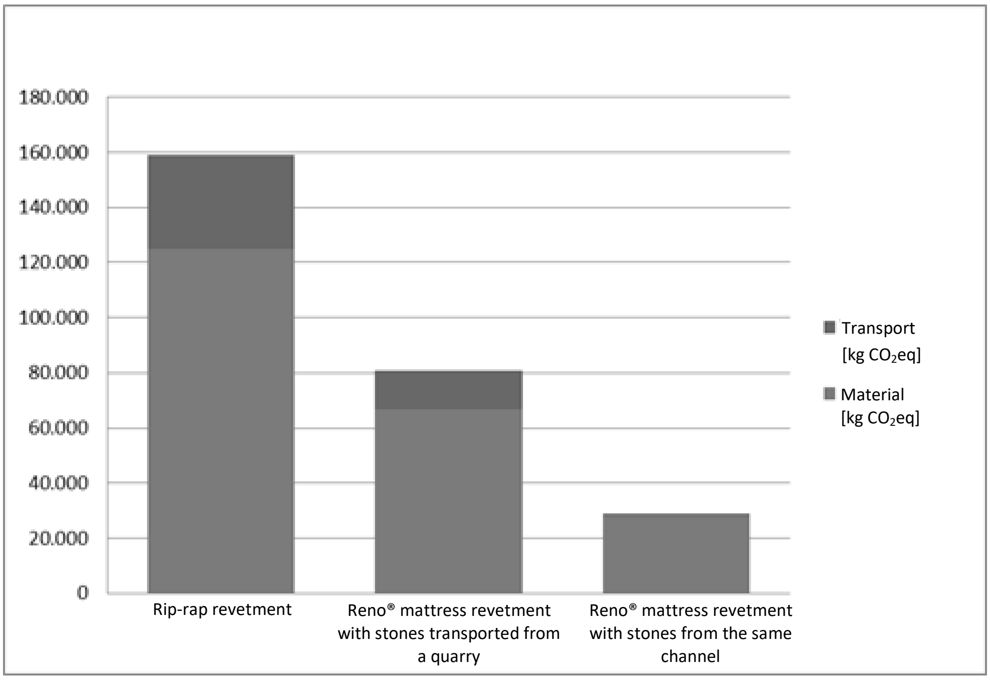

Figure 5. - Comparison between the CO_2 emissions related to the construction of margin protection: traditional solution (rip-rap) vs. Reno® mattress covering (with quarry stones and extracted from the bed)

To standardize the results, the total tons of CO_2 calculated for each structure were divided by their own total area, thus obtaining a generic unit of measurement: tons of CO_2/m^2eq.

Were considered:

- 80 m^2 external wall surface
- 5,400 m^2 of margin protection area

The calculated emission of the solution in gabions was thus of 58 t and 95 t of CO_2/m^2, depending on whether the origin of the stones was quarry or local respectively, while the calculated emission of the concrete solution was 665 t of CO_2/m^2.

In the case of the coatings, the calculated emission of the Reno® mattress solution was 5.4 t and 15 t CO_2/m^2, depending on whether the origin of the stones was local or quarry, respectively, while the calculated emission of the traditional solution (rip-rap) was 29 t CO_2/m^2.

CONCLUSION

Concluding the study, the results of the two studies were compared, and it is possible to conclude that:

The carbon footprint of works in Reno® box and mattress gabions is extremely inferior to works with the same purpose, built in concrete or loose stone, respectively.

- In the first case, the reduction of CO_2 emissions is of the order of 80% to 90% and.
- in the second from 80 to 50% depending on the respective transport distance.

This evaluation is important when it is necessary to take into account in the design of river works, not only the technical and economic aspects as has been usual up to nowadays, but, as it is auspicious, also those related to the environmental impact that these produce.

REFERENCES

APMC, (2012). “*Carbon Footprint dei Gabbioni e Materassi Maccaferri e confronto con soluzioni tradizionali*” (Unpublished).

D’Andria, D. (2016). “*Carbon Footorint dei prodotti doppia torsione*” (Unpublished)

Fracassi, G**.** (2017). “*Proteção de rios com Soluções Maccaferri*”. Oficina de textos, São Paulo, Brasil. pp. 171-185.