



HAL
open science

COMPARATIVE LIFE CYCLE ASSESSMENT OF TWO INSULATED WALLS

Jean-Luc Menet, Ion-Cosmin Gruescu

► **To cite this version:**

Jean-Luc Menet, Ion-Cosmin Gruescu. COMPARATIVE LIFE CYCLE ASSESSMENT OF TWO INSULATED WALLS. 2nd LCA Conference, Nov 2013, Lille, France. 5 p. <hal-00949666>

HAL Id: hal-00949666

<https://hal.science/hal-00949666v1>

Submitted on 21 Feb 2014

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

COMPARATIVE LIFE CYCLE ASSESSMENT OF TWO INSULATED WALLS

Jean-Luc MENET (1), Ion-Cosmin GRUESCU (2),

- (1) ENSIAME, Université de Valenciennes et du Hainaut-Cambrésis
Le Mont Houy 59313 Valenciennes Cedex
jean-luc.Menet@univ-valenciennes.fr
- (2) Université Lille 1 - Sciences et Technologies, IUT "A", Département GMP,
Rue de la Recherche, BP 90179, 59653, Villeneuve d'Ascq Cedex
ion-cosmin.gruescu@univ-lille1.fr

Abstract

The present study presents some results obtained by applying the LCA methodology to evaluate the environmental footprint of a wall. The approach is motivated by the increasing number on markets of new materials such the mono-wall blocks, which are offering interesting insulation properties.

The proposed study focuses on a comparison between two walls with the same thermal resistance. The environmental footprint of a wall made by using mono-wall blocks is then compared to a classical wall made with breeze blocks and glass wool.

The environmental impacts are evaluated by using the Eco-invent 2.0 data-base, with midpoint indicators associated to the CML method.

The main result of the study is very interesting: it appears that the mono-wall block is not better for the environment than a classical wall correctly insulated.

Keywords

Life Cycle Assessment, LCA, wall, environmental impacts, climate change indicator

1. INTRODUCTION

Building industry must overcome nowadays major difficulties, mainly because of the very important energy consumptions and of the big quantities of raw materials employed to ensure hygro-thermal and acoustic properties or different other comfort facilities and economical performances to the main's building elements such the walls. The passive buildings seem to be the right solution permitting a decrease or at least a stabilization of climate change indicators. Because of this fact, national legislations are progressively introduced; the lecturer can refer for more details to the so called RT 2012 French thermal regulation [1].

Note also that the requirements and the legislation relative to the building's envelope performance vary from a country to another and they are all very restrictive. The construction systems must consequently be adapted to each specific decision or design context.

The Life Cycle Assessment methodology, which is a standardized approach [2, 3] allows the quantification of the environmental footprint for goods, services and processes. It is then

possible to identify some main points allowing the diminution of the environmental impacts since their earlier design stage. This methodology is regularly used in the field of building industry, for example in [4]. We have recently used the LCA methodology for performing some case studies concerning walls; it has been shown that the “common sense” generally leads the user to do very bad choices in the materials selection, from an environmental point of view [5,6,7,8].

Among different solutions which are proposed to the builders, one consists to use adapted building elements, such the specific bricks called *mono-wall blocks*, which have the particularity to ensure both the function of a brick (or a breeze block), and the one of insulation. Besides, this permits a time gain because these elements are easy to implement. In summary, this element is a brick made of terra-cotta and has an alveolus structure material which ensures the insulation (figure 1).



Figure 1: A typical mono-wall brick

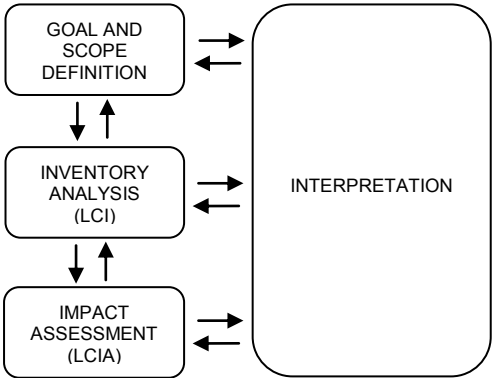


Figure 2: Different phases of the LCA methodology [2, 3]

In the present work, two walls are considered: a classical wall made of breeze blocks and a wall built with mono-wall blocks. This paper presents the results of a LCA study made on the walls following the standardized methodology reported on figure 2.

2. GOAL AND SCOPE DEFINITION

The goal of the present study is the comparison of environmental impacts of the two considered walls.

The study is made by considering 1m² of wall insuring a thermal insulation resistance of 2.6 K/W. The time life of the wall is supposed to be 100 years (usual replacement time considered in the building area in France), but the environmental footprint is calculated only for 10 years. The joins are taken into account. The different tools used for the building are not taken into account. In the two cases, the blocks are supposed to be produced at a distance of 300 km from the distributor, which is supposed to be 10 km far from the user. Only the wood pallets are considered for the transportation of the blocks. All the steps of the LCA methodology are considered. The packaging of the glass wool is not considered.

3. INVENTORY ANALYSIS

Only the main data are reported in the following. More details about the inventory analysis can be found in ref [9]. The parameters used for the two studied walls are presented in the Table 1.

Table 1: Main characteristic of the mortar and of the considered wall area

Properties	Mono-wall block	Breeze block
Density (Kg/m ³)	1300	1300
Height of the wall area (m)	1.065	1.05
Lenght of the wall area (m)	0.939	0.952
Volume of join (m ³)	1.41 . 10 ⁻³	1.41 . 10 ⁻²
Mass of joins (kg)	1,831	24.9

3.1 Wall made of mono-wall blocks

Every block weights 16.5 kg, and has the following dimensions: 30cm x 30 cm x 21.2 cm. No vertical join is necessary for the building of mono-wall blocks. The horizontal join is supposed to be 1mm thick; table 1 shows the main characteristics of the mortar used forit.

3.2 Wall made of breeze blocks

Every block weights 17 kg and has the following dimensions: 20cm x 20 cm x 50 cm. The vertical and horizontal joins are about 1.5 cm thick. In Table 1 are presented the main characteristics of the mortar used for the join. To achieve the same thermal behavior, a glass wool panel must be added to the present wall (thickness: 80mm).

4. IMPACT ASSESSMENT

In order to evaluate the environmental impacts from the inventory analysis, the Eco-invent 2.0 data-base is used [10]. The environmental impacts were estimated using midpoint indicators associated with the CML method [11]. Since each indicator has a different scale and unit of measurement, the relative impacts are normalized, according to the specifications of ISO procedures [2,3]. Each indicator is then expressed in points (see Figures 3 and 4). A point represents the potential impact for a given indicator divided by the value of the same impact for a mean European people during one day. The chosen indicators and the corresponding units are reported in table 2.

Table 2 – Chosen indicators for the calculation of the environmental impacts

Letter	Indicator	Unit
A	non-renewable energy consumption	MJ eq.
B	resources depletion	kg Sb eq.
C	100 year Global Warning Potential	kg CO ₂ eq.
D	Acidification	kg SO ₂ eq.
E	Eutrophication	kg PO ₄ ²⁻ eq.
F	photochemical pollution	kg C ₂ H ₄ eq.
G	aquatic toxicity	kg 1.4-DB eq.
H	human ecotoxicity	kg 1.4-DB eq.

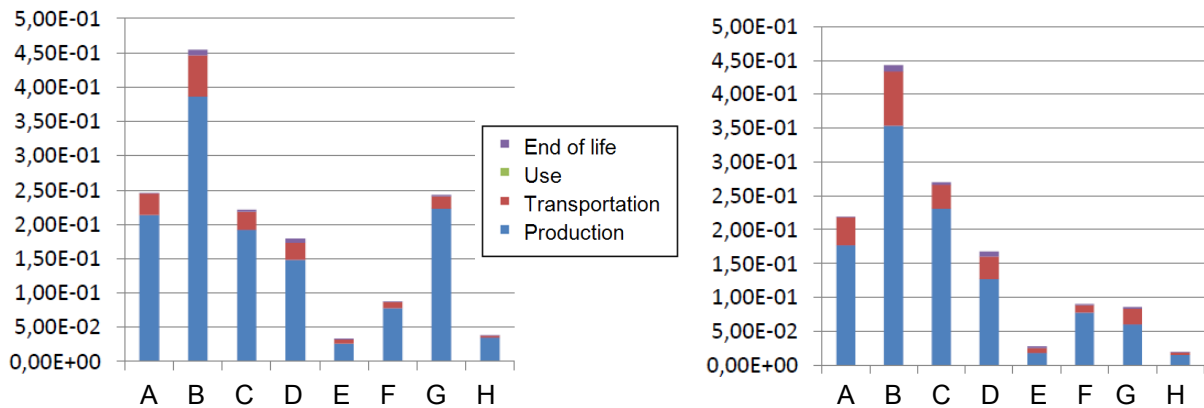


Figure 3: Environmental impacts for each life phase
 (a) : breeze blocks and glass wool
 (b) mono-wall blocks

4. CONCLUSION (INTERPRETATION PHASE)

The comparison of the two walls leads to two main conclusions:

- In both cases, the production phase leads to the more important environmental impacts than the classical wall, except for aquatic ecotoxicity, which is mainly due to the mortar used for the joints;
- Considering the whole life cycle, there is no significant difference in the environmental impacts whatever the indicator.

Consequently, because of the errors margins, it is in fact impossible to affirm that the wall made with mono-wall blocks is better for the environment than a classical wall correctly insulated. This main conclusion seems to show equally that the systematic choice of mono-wall blocks for new buildings is due to the prices and the easiness of implementation rather than the environmental characteristics of this material.

This fact is the more important, since it is easily possible to replace glass wool used in the conventional configuration by natural insulation materials, which will lead to an environmental footprint lower to the one of the wall made with mono-wall blocks.

ACKNOWLEDGEMENTS

This study has been partly made using the free Bilan Produit ® software [12] jointly developed by the *French Agency for the Environment and the Energy* (ADEME) and the Cergy-Pontoise University.

The authors thank the students C. Ghillebaert, A. Doulcet and S. Manson which have worked on the subject during their university projects [9].

REFERENCES

- [1] Décret n° 2010 du 26 octobre 2010 relatif aux caractéristiques thermiques et à la performance énergétique des constructions, (Journal Officiel de la République Française, 2010 oct. 27th).
- [2] ISO 14040: 2006, Environmental management - Life cycle assessment - Principles and framework, (2006).

- [3] ISO 14044: 2006, Environmental management - Life cycle assessment - Requirements and guidelines, (2006).
- [4] Frenette, C.D., Bulle, C., Beauregard, R., Alexander Salenikovich, A., Derome, D., 'Using life cycle assessment to derive an environmental index for light-frame wood wall assemblies, *Building and Environment* **45** (10), (2010), 2111–2122.
- [5] Gruescu, I.-C., Menet, J.-L., Environmental footprint of a wall assembly by Life Cycle Assessment, 2nd LCA Conference, Lille, 6-7 nov 2012.
- [6] Menet, J.-L., Gruescu, I.-C., A comparative life cycle assessment of exterior walls constructed using natural insulation materials, *Environmental Engineering and Sustainable Development Entrepreneurship* 2 (4) (2012).
- [7] Menet, J.-L., Environmental footprint of walls using natural materials coming from agricultural wastes, ECGP11, 11^è Symposium International Environnement, Catalyse et Génie des Procédés, Lille, 26-28 june 2013.
- [8] Menet, J.-L., Gruescu, Environmental footprint of building elements using Life Cycle Analysis methodology, 21^è Congrès Français de Mécanique, Grenoble, 20-30 août 2013.
- [9] C. Ghillebaert, A. Doulcet and S. Manson Analyse de cycle de vie Parpaing & Brique monomur, Project Report, ENSIAME (2011).
- [10] <http://www.ecoinvent.ch/>
- [11] <http://www.leidenuniv.nl/interfac/cml/ssp/projects/lca2/index.html>
- [12] <http://www.ademe.fr/bilanproduit>

ACV comparative d'un mur classique et d'un mur réalisé en briques mono-mur

Le but de l'étude est de comparer les impacts environnementaux de deux matériaux de construction en utilisant la méthodologie ACV : le parpaing et la brique mono-mur.

La brique mono-mur est connue pour sa facilité de mise en œuvre et ses caractéristiques isolantes. Pour comparer un mur utilisant ce matériau à un mur classique (parpaings), il faut donc adjoindre à ce dernier une couche isolante ; nous avons choisi la laine de verre.

L'unité fonctionnelle doit être précisément définie pour que la comparaison soit possible, raison pour laquelle le paramètre considéré est la résistance thermique. Les phases considérées sont l'extraction, la fabrication, le transport et la fin de vie. Le conditionnement des matériaux est également pris en compte.

Dans l'analyse comparative, on constate que les indicateurs sont du même ordre de grandeur pour les deux murs, sauf pour l'éco-toxicité aquatique où le mur en parpaings a une empreinte trois fois supérieure à celle du mur en briques mono-mur. Ceci est principalement dû au mortier qui est utilisé en plus grande quantité dans le cas du mur classique. Pour tous les autres indicateurs d'impacts, la différence est trop faible pour être significative et elle est dans tous les cas supérieure à l'incertitude.

De manière générale, on note que l'utilisation de briques mono-mur dans la construction des bâtiments n'est pas si intéressante que cela d'un point de vue environnemental. Dans le cas d'un mur classique, une optimisation du mortier réduirait très sensiblement l'empreinte environnementale. Par ailleurs, l'utilisation d'un isolant issu de matériaux bio-sourcés pourrait aider à la diminution des impacts environnementaux du mur classique, ce qui le rendrait très supérieur à un agencement de briques mono-mur au regard de ses performances environnementales.