TECHNICAL NOTE #02

Life Cycle Assessment of masonry walling

This Technical Note is a discussion document in preparation for the Life Cycle Assessment (LCA) project to be undertaken by The University of Pretoria with the assistance of the Department of Science and Technology. It reviews scoping challenges and methodology options and outlines expectations around data to be measured and assessed for a brick sector LCA in South Africa.

TECHNICAL CONTRIBUTORS

CBA Technical Committee

SECURE SAVE SUSTAIN STYLE

CLAYBRICK.ORG

environment-friendly

EXECUTIVE SUMMARY

This Technical Note is provided as a discussion document and an information sheet in advance of a significant Life Cycle Assessment (LCA) project to be undertaken for the CBA by Pretoria University in conjunction with the Brick Industry and with the assistance of the Department of Science and Technology in terms of THRIP financing.

The Clay Brick Association of South Africa has plenty to be proud of in terms of its contribution to the national economy and progress along the path of improved sustainability. Heightened awareness for the job creation, energy performance and environmental awareness, have enabled clay brick to earn sustainability credentials and be synonymous with 'green'. We continually disseminate information on our Member's progressive and proactive practices, and invest in National Standards development, product testing and research into new technologies.

The decisions of building material specifiers are heavily influenced by the societal need for long-term sustainability, and clients who wish to be leading or part of this, are moving towards making decisions that 'tread more lightly on the planet'.

Clay Brick has good environmental credentials when compared with steel and aluminium (based on international research) and this data needs to be made available to the building industry and its clients so they can assess for themselves where Clay Brick masonry stands compared to other materials. We also need to identify where improvements can and should be made to keeps members ahead of the competition in terms of strategic issues.

In order to maintain our leadership position, the CBA Technical Committee is recommending an ambitious project in terms of size of task, cost and duration: An Industry Life Cycle Assessment (LCA).

OBJECTIVES OF THE LCA

The LCA should report on the expected social, economic and environmental impacts of clay brick manufacture and masonry buildings in the RSA.

Environmental impacts, in particular energy use and resultant greenhouse gas emissions, water, recyclability and local air quality associated with the manufacture of bricks, and the production and operation of BRICK masonry houses and other structures over their expected life-span within RSA should be gauged. This will allow clay brick residential and non-residential buildings to be fairly compared with those constructed from other materials, in accordance with the guiding provisions of ISO14040/14044.

The LCA will be an ongoing process as it maps out the improvements which are made in terms of all metrics into the future.

ANTICIPATED OUTCOMES OF THE LCA IN SOUTH AFRICA

South African masonry walling can be expected to perform similarly to Australian masonry, as is shown in the Energetics Australia Life Cycle Assessment (LCA). This comment is based on observations of similar trends demonstrated in CBA research (thermal modelling results) and published Australian reports, and taking into account that the climate zones of these two countries are very similar. Other factors that may have an influence include:

a) The Australian electrical power usage intensity, building methods, as well as coal and gas costs are very similar to that of South Africa.

b) Significant distances need to be covered by distributors of fired clay products to reach building sites in both countries.

Factors that will need to be reported on (in greater detail than the Australian Energetics LCA report) are the social and economic aspects. The employment creation within the bricklaying and associated trades in the RSA is a factor of National interest, and a pillar on which Clay Brick manufacture and masonry walling industry stands.

SUGGESTED METHODOLOGIES

A detailed analysis of the various extraction, production, distribution and construction aspects, as well as the dematerialisation impacts on energy, and the greenhouse gas performance of masonry in residential and non-residential structures over its life cycle needs to be followed.

The energy mix will need to be closely analysed, as will the atmospheric pollution record of the South African brick manufacturers, the water impacts in all phases, and also the recycling realities within the RSA.

The LCA will consider all of the following life cycle stages, for impacts in respect to all environmental factors:

- Clay extraction
- Brick manufacture
- Transport to site
- Construction methods including production and use of mortar
- Use of house/office by occupants, including energy usage and maintenance considerations
- Demolition, recycling/reusing and disposal

Recommendations and Way Forward

The Green Buildings Council and Sustainability experts WSP Energy & Environment have been consulted for suggestions on the approach to be followed.

It is recognised that in terms of energy/carbon balance, the focus of any LCA/impact analysis should be on the usage/operational phase for clay bricks, as the manufacturing aspect is comparatively small. This is as per the approach followed in the WSP Green by Design analyses conducted to date, as well as that followed in the Australian study.

WSP note that the above studies are principally focused around the question of energy/carbon. This is, however, only one component to a holistic LCA study. When other flows are considered, such as water or waste for example, the focus of analysis is likely to be on the raw materials/manufacturing aspect of the life cycle (e.g. air emissions from manufacturing are a known potential impact of concern in the South African context).

Socio-economic 'flows' would likely need careful scrutiny across the entire lifecycle. While it might be defendable to exclude socio-economic or environmental (i.e. waste/air emissions) considerations from the Australian LCA study, we would advise that this would not be the case in the South African context, where environmental compliance and regulation is underdeveloped and social issues are obviously important.

In order to produce a comprehensive LCA study that will truly add value to CBA membership and the market, a phased approach is required in which critical components of the full LCA are completed as priority projects, allowing for deliverables and value to be accessed quickly, while continuing to integrate all aspects into a master LCA study.

We recommend that an initial strategic level LCA study be undertaken to define the goals and objectives of the final LCA (step one of LCA framework), and to qualitatively analyse each component input required for the final LCA. This would allow for key information gaps to be identified and component specialist studies to be scoped correctly.

An initial horizon scanning exercise would cover the following three key areas in detail:

Energy & Water

Manufacturing portion of lifecycle:

Certain brick manufacturers have already quantified their carbon emissions, whilst others have not. Water footprint information of manufacturing is likely to be even more limited (albeit of lesser importance for this sector). There is an opportunity for the CBA to create a sector specific disclosure process, similar to the highly effective international Carbon Disclosure Project (CDP).

Usage portion of lifecycle

Energy modeling has already been undertaken for the SA context, but it is likely that more detailed work would be required as this is such a key input component in respect of energy flows to the overall LCA.

Environmental Impacts

In terms of environmental impacts, air emissions during manufacture would be a key consideration for which there is currently inadequate quantitative data for South African operations. New air quality legislation and licensing requirements, will however mean that emission monitoring must be done by manufacturers by early 2014. The pragmatic approach is thus to setup up the agreements with CBA members to allow for confidential disclosure and analysis of this data (for use in LCA analysis) rather than initiative costly parallel studies.

Socio-economic Considerations

The precise scope of socio-economic analysis to be included in the final LCA needs to be decided, however, it would be an oversight not to provide some measure of analysis and assessment of at least basic labour metrics, etc. in the envisaged LCA study.

Methodology

The methodology for integration of the LCA data with the compilation of Building Sustainability Indices should be by way of a universally accepted method, and the LCA should provide for this. The assessment should be developed in line with the requirements of ISO 14040 series of environmental standards, as these are the international benchmark for this type of assessment.

The LCA procedure comprises four steps (according to ISO 14040 and ISSO 14044)

1. Goal and Scope Definition

From the onset, the goal and scope of the study is defined in order to determine where the system boundaries for the LCA are to be set, as well as to ascertain which products will be analysed, as well as the processes to be included in the LCA study.

During this first step, the functional unit has to be determined. This is the unit to which all inputs and outputs of the inventory analysis and impact assessment results refer. The new paradigm is possibly Cradle to Cradle in place of Cradle to Gate.

2. Life Cycle Inventory Analysis (LCI)

The next phase is the Life Cycle Inventory Analysis (LCI), where a life cycle model is created, that includes all relevant inputs (raw materials, energy) and outputs (solid, waste, emissions) for the studied product.

For all inputs and outputs, appropriate inventory data needs to be procured. Usually the life cycle model depicts the entire life cycle of a product, from manufacture to disposal. Consequently, a long list of all inputs and output streams is the result. Since an interpretation of that list in terms of identifying the environmental impact of the product is rather difficult, a further step is required.

3. Life Cycle Impact Assessment (LCIA)

Classification and characterisation of the LCI results designate the Life Cycle Impact Assessment (LCIA).

In this step, the inputs and output results from the LCI phase are sorted and assigned to environmental impact categories such as global warming potential, ozone depletion, human toxicity, eco-toxicity, photochemical reaction, acidification, eutrophication, resource depletion, land use and product recyclability.

There are also varying environmental impact assessment methods (e.g. Eco Indicator 99, ReCiPe and Ecological Scarcity), which perform a weighting of the individual environmental impact categories.

4. Life Cycle Interpretation

In the interpretation step of the LCA, the results are then analysed and documented.

Context of the LCA

Comparative information

It may be necessary to place the Clay Brick LCA in the context of other materials and systems, and in the absence of a similar LCA from other sectors. The scope of the project may need to be expanded to be comparative against other building materials and systems. At this stage, in view of the paucity of information in other sectors, it may be prudent not to attempt to draw comparisons.

BUILDING SYSTEMS

The following systems are proposed to be considered:

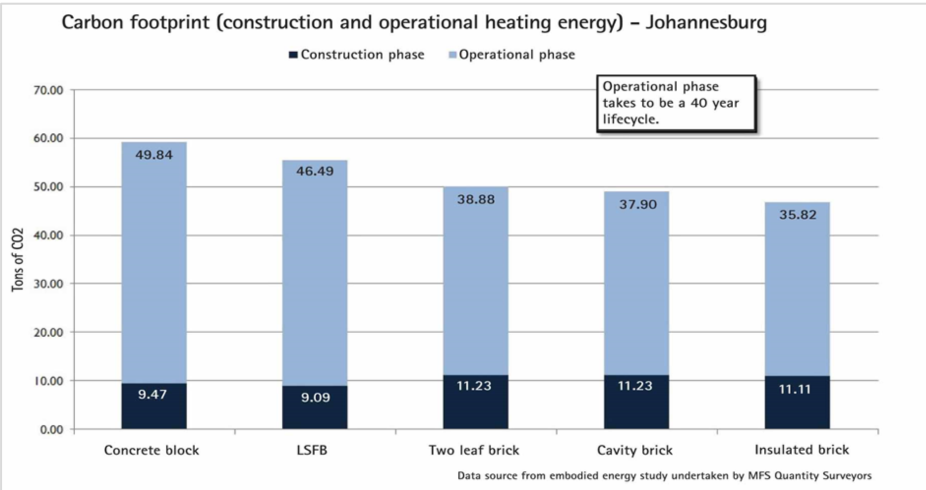
- Double brick cavity wall (un-insulated)
- Insulated double brick (various R-values)
- Light Steel Frame building systems
- 140mm Hollow concrete block
- Timber Frame with fibre-board

WASTE GENERATION

The impact on land fill sites of non-recyclable products in comparison with masonry products, and waste as result of a lack of modularity may receive attention.

CARBON FOOTPRINT

The WSP energy modelling of various sized houses are indicative of the major portion of the building usage energy impacts and these are reported below.



BUILDING DESIGNS, ASSUMPTIONS AND ORIENTATION

1. Residential house; 40m^2
2. Residential house: 130^2
3. Non-residential Office of 2000m^2

Modelling and design to be based upon SANS 10400XA and SANS 204 requirements.

LOCATION

Six different climate zones are to be evaluated; As per SANS 10400XA Climatic Zones.

REPORT OUTPUTS

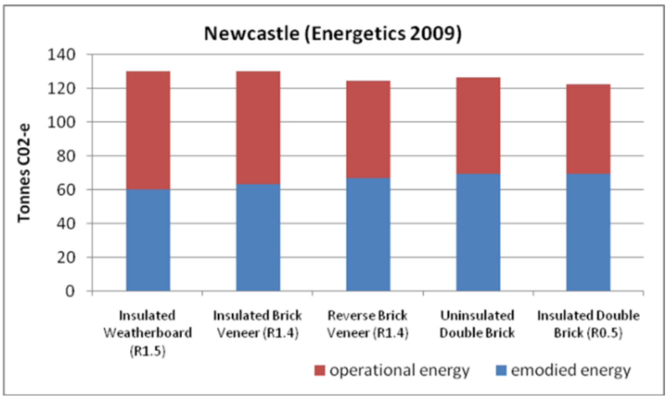
Environmental impact per Mt or kg brick to be determined. Factors considered included:

- Demand for renewable energy resources (MJ)
- Demand for non-renewable energy resources (MJ)
- Greenhouse effect (kg CO_2 or equivalent)
- Ozone depletion (kg R11 or equivalent)
- Photosmog (kg Ethylene or equivalent)
- Acidification (kg SO_x or equivalent)
- Nitrification (kg PO_4 or equivalent)

Embodied energy

The embodied energy should be an output along with operational energy as is shown in the Energetics LCA for Australia.

The methodology for calculation of this aspect will need to be carefully considered.



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2. *Design of a simplified comparative ecological and economic LCA tool for Swiss residential apartment buildings – A Methodological approach*: V John, H Wallbaum
3. *A methodology for the development of a sustainability index for construction works in Spain* C A Rozado, J G Navarro

CONCLUSION

This document sets out what may be expected from a LCA, and proposes some of the requirements and the methodological approach. Any further contributions should be emailed to the Executive Director of the Clay Brick Association who will be pleased to canvas your views.

For further information:
The Clay Brick Association of South Africa
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