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TECHNICAL NOTE #2

Life Cycle Assessment
Masonry Walling

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Technical Note 2

Life Cycle Assessment of Masonry Walling

Title

A discussion paper on the 'Life Cycle Assessment of Masonry Walling' to be conducted by the Clay Brick Association of South Africa (CBA).

Executive Summary

The Clay Brick Association of South Africa has nothing to hide and plenty to be proud of in terms of its contribution to the national economy and progress along the path of improved sustainability.

The job creation, both direct and indirect, and the heightened energy performance and environmental awareness, have enabled the CBA to take the 'high ground' in terms of 'owning the sustainability jacket' and re-branding the industry as being synonymous with 'green'. The image of the industry is one of progressive and proactive practices.

This position is earned by the various marketing activities undertaken by the CBA, and a strong market presence, and by supporting these activities with good science, contribution to National Standards development, product testing and investments by the brick manufacturers in the correct technologies.

The CBA is the 'Voice of the Clay Brick industry' and the CBA brand one of jealously guarded integrity.

The CBA Technical Committee has been set up to provide the industry with the necessary resources to explain and support industry claims, and to prevent any possibility of the industry being labelled as 'greenwashing'.

The decisions of building material specifiers are being more and more 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, as a product has good environmental credentials when compared with steel and aluminium (based on international research), and the same data needs to be available for the industry and clients to know where Clay Brick masonry stands vis-a-vis the competition, in order to see where improvements can and should be made.

The work which has been done by the CBA Technical Committee, to date, has ensured that this information is available to the specifier, as well as the Association members, and keeps the CBA ahead of the competition in terms of strategic issues. In order to maintain this leadership position, the CBA Technical Committee will be promoting an ambitious project in terms of size of task, cost and duration: An Industry Life Cycle Assessment (LCA).

Requirement 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 masonry houses and other structures over their expected life-span within RSA should be gauged, in order for the sustainability of the industry to be fairly compared with that of houses and other buildings 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, and will lay down the gauntlet to the competition.

Anticipated Outcomes of LCA on Masonry Walling in the RSA

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 for a CBA Approach

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 a house/non-residential structure 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

Advice of Experts

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

WSP Recommendations and Way Forward

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.

WSP Recommendations and Way Forward, cont'd

The advice is that in order to produce a comprehensive and defensible LCA study that will truly add value to CBA membership and the market, ***a phased approach*** is required in which critical component aspects of the full LCA are developed as priority projects, allowing for deliverables and market/CBA member value to be produced as soon as possible from the studies while working towards integrating all aspects into a final master LCA study.

We recommend that ***an initial strategic level LCA study be undertaken***. The objective of this would be 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 horison scanning exercise would cover the following three key areas in detail:

- **Energy & Water:**

  - **Manufacturing portion of lifecycle**:
    We are aware that 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). WSP have recently completed the first water disclosure report for South Africa and would be excited to discuss how a similar process could be setup by the CBA for the Clay Brick manufacturers in SA.

  - **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 would need to be discussed with the CBA, 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.

Methodological Requirements

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 consecutive steps (according to ISO 14040 and ISSO 14044)

1.1.1 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.

1.1.2 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.

1.1.3 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.

1.1.4 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 for consideration:

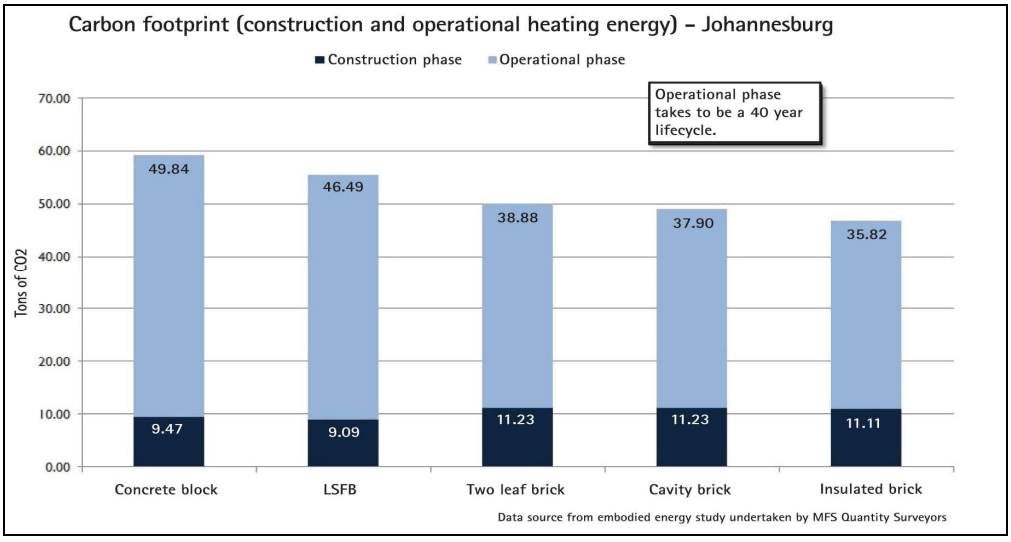
- Double brick cavity wall (un-insulated)
- Insulated double brick (various R-values)
- Light steel frame building systems
- 140mm hollow concrete block
- Timber frame with fibre-board

Waste Generation:

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

Recent CBA Research:

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.



Context of the LCA, cont'd

Building Designs, Assumptions and Orientation

- Two house designs are to be considered, i.e. 40m^2 and 130m^2
- For non-residential construction a small office design of 2000m^2 is proposed
- Modelling and design is to be based upon current SANS 10400XA and SANS 204 requirements.

Location

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

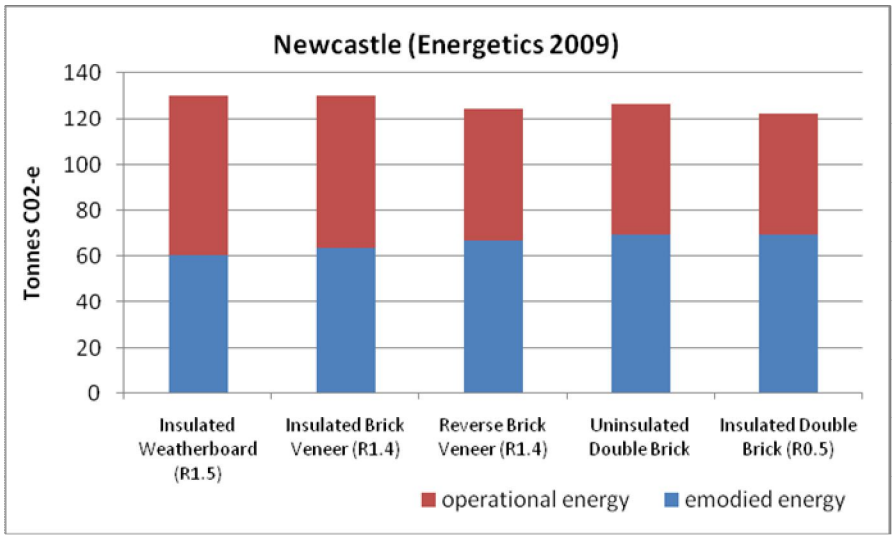
Report Outputs

The average environmental impact per Mt or Kg brick will be determined. Factors considered include:

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

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.



Conclusions

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 At Coetzee, Executive Director of the Clay Brick Association who will be pleased to canvas your views. Email: at@claybrick.co.za.

References

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2. Design of a simplified comparative ecological and economic LCA tool for Swiss residential apartment buildings – Methodological Approach, by Viola John, Holger Wallbaum
3. A methodology for the development of a sustainability index for construction works in Spain by Carmen Antuña Rozado Justo García Navarro