TECHNICAL NOTE #8

Carbon Footprint

Clay Brick Masonry Walling in South Africa

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Title

The Carbon Footprint in terms of Clay Brick Masonry Walling in South Africa

Status

This Technical Note is provided as an information sheet for appending to the ClayBrick.org website.

Scope

A review of the Energetics Life Cycle Assessment for brick masonry in Australia, in addition to papers published at the Sustainability Conferences SB10 & 11, as well as those developed on behalf of the Clay Brick Association of South Africa (ClayBrick.org), among other sources.

Methodology

Publications around the principles of Sustainable Development are reviewed. Articles published during the proceedings of SB10 and SB11, and earlier articles published by ClayBrick.org on the topic of Sustainability and a Life Cycle Assessment of Masonry in Australia were reviewed as possible indicators for relevance to Clay Brick Manufacture and usage in South Africa.

Outline

→ Sustainability Principles
→ Why Carbon is Central to Sustainability Measurement
→ Measurement of Carbon Emissions
→ Carbon Footprint Expectations for RSA
→ Conclusions

Sustainability Principles

Sustainable Development is development, which meets the needs of the present without compromising the ability of future generations to meet their own needs.

Accordingly, **Environmental Sustainability** is the process of making sure current processes of interaction with the environment are pursued with the idea of keeping the environment as pristine as is naturally possible, and such that nature's resources are not used up faster than they can be replenished.

Economic Sustainability views the economy and the environment as a single interlinked system. If these economic human activities discriminate against future generations, these are clearly unacceptable and efficient policies will be compatible with increasing human welfare i.e. **Social Sustainability**.

Why Carbon is Central to Sustainability Measurement

The pollution of the planet via heavy metals, Dioxins, Chloro-Phenyls, radioactive waste, etc. are all environental hazards which could annihilate all forms of life on earth. Other poisons such as oxides of Nitrogen and Sulphur could also destroy in dramatic fashion, but few poisoning systems are as insidious in contaminating the earth's atmosphere, as is Carbon Dioxide - a product of the respiratory process of all life with input to the photo-synthetic process of plant growth which has for many years been thought to be in a neat balance, and is now recognised as causing the over-heating of our environment. This is the Greenhouse Gas (GHG) phenomenon, which is overshadowing the impact of other toxins and pollution.

Greenhouse Gases can be emitted through transport, land clearance, the production and consumption of food, fuels, manufactured goods, materials, wood, roads, buildings, and services. For simplicity, it is often expressed in terms of the amount of Carbon Dioxide, or its equivalent of other GHGs emitted. These Greenhouse Gases get emitted into the atmosphere causing absorption of infrared radiation that would have otherwise escaped into space. Increased absorption of infrared radiation leads to an increase in the average temperature of the earth.

A **Carbon Footprint** has historically been defined as 'the total set of Greenhouse Gas emissions caused by an organisation, event, product or person'. More practically it can be described as 'a measure of the total amount of Carbon Dioxide (CO_2) and Methane (CH_4) emissions of a defined population, system or activity, and considers all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. It is calculated as a Carbon Dioxide equivalent (CO_2-e) using the relevant 100-year global warming potential (GWP100).

The concept of Carbon Footprint emanates from ecological footprint discussions, as a subset of a more comprehensive Life Cycle Assessment (LCA). Thus, allowing for the Carbon Footprint of an individual, nations or organisations to be measured.

Measurements of Carbon Emissions Used in Masonry Walling

In performing a GHG Emissions Assessment it would be required to measure all global warming (kg CO_2-e) equivalents. The main Greenhouse Gases are water vapour, Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O), which are combined as CO_2 equivalent units.

The equivalent factors, Global Warming Potentials (GWP's) describe the potential severity of each Greenhouse Gas in relation to the reference CO_2. They are derived from the IPCC (Intergovernmental Panel on Climate Change).

Much of the above are caused by the burning of fossil based fuels. As a result of the bias towards fossil based primary energy source for electricity the Cumulative Energy Demand (CED) is measured in mega-joules (MJ) as a surrogate for GHG emissions. This is the total quantity of primary energy needed throughout (or part of) a life cycle. CED is not directly linked to an environmental mechanism, as it does not distinguish between various forms of primary energy with different environmental effects.

As part of a Life Cycle Assessment, the GHG emission assessment of the product systems of bricks, brick walls and house/building designs have to be standardised and attributed, in useful and acceptable inventory units, i.e. the Life Cycle Inventory (LCI) :

→ Bricks	(1 SBE)	cradle-to-grave
→ Brick assembly	(1m^2 wall)	cradle-to-grave
→ Brick assemblies in house design	(1 house)	cradle-to-grave

A set of well defined and harmonised indicators make sustainability tangible, and are used as input to the Life Cycle Impact Assessment (LCIA). This is a classification and characterisation of the LCI results. In this step, the input 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 and land use.

There are various environmental impact assessment methods, for example Eco Indicator 99, ReCiPe and Ecological Scarcity, which are used to perform a weighting of the individual environmental impact categories.

Carbon Footprint Expectations for South Africa

Comparisons of Life Cycle Greenhouse Gas impacts between various wall construction types in a typical 12m x 21m floor plan (Sirocco, Melbourne, East facing, 50 years) indicate an Embodied Life Cycle impact (excluding HVAC) and a Total life Cycle impacts (including HVAC) of 75.9 and 135Mt CO_2e respectively for an insulated double brick wall construction. Without the thermal insulation the wall would have an additional HVAC energy premium and the CO_2 equivalent would be some 8% higher. In reviewing the WSP modelling results for the 130m^2 home over 40 years, a result (37MtCO_2) is indicated, however the period of analysis, size of house and climatic assumptions are different.

Conclusions

There is a fair closeness of comparison between the Carbon Footprint calculated in the Energetics report to ThinkBrick Australia and the WSP result on cursory examination.

An estimation of masonry Carbon Footprint for the RSA will be valuable data for comparative analysis against other forms of construction.

References

1) Full Life Cycle Assessment by Energetics, University of Newcastle, on behalf of ThinkBrick Australia

2) Design of a simplified comparative ecological and economic LCA tool for Swiss residential apartment buildings – Methodological approach, Viola John, Holger Wallbaum

3) A methodology for the development of a sustainability index for construction works in Spain, Carmen Antuña Rozado Justo García Navarro.