SKANSKA

The Greenest Building: Quantifying the Environmental Value of Building Reuse

MATERIALS QUANTIFICATION METHODOLOGY

Overview

This document summarizes the method and scope of analysis for quantifying materials used in the case studies that served as the basis for this LCA analysis. The same methodology was employed for each of the six building typologies studied, with minimal variation.

Project Selection

Most of the projects presented in this study are located in the Pacific Northwest. The construction materials used in each case study of this analysis are appropriate and typical for their respective locales and climates.

In selecting the projects for analysis, it was important to consider whether case studies from a single region would introduce errors, because different regions of the country can employ different materials and construction methods. The team reviewed each of the case study buildings, by region, for differences in materials, and determined that there was no significant impact to material usage or application by region that would require adjustment to the methodology; the materials used in the study projects were found to be typical across typologies, regardless of the projects' respective geographic locations.

The projects in this study were also reviewed, by typology, to verify the consistency of materials between New Construction (NC) and Rehabilitation and Retrofit (RR) projects. To the extent practicable, within a given typology category, the project team sought to ensure an 'apples-to-apples' comparison of buildings; for example, buildings with masonry exteriors are compared to buildings with masonry exterior, wood-framed structures are compared to other wood-framed structures, and so forth. Nevertheless, some variation in materials between NC and RR structures was unavoidable, as buildings of the same typology make use of different materials.

It was important to ensure that result findings would be generalizable. Therefore, projects were also selected to be as representative as possible of newly constructed or renovated buildings of specified typologies.

Which Materials Were Quantified?

This study quantifies the materials needed to construct a new building or renovate an existing building. The materials needed to improve energy efficiency in both the NC and RR case studies are also quantified.

This study is primarily concerned with those impacts that can be avoided by reusing an existing building versus building anew. Thus, materials quantification in this study does **not** include materials that remain in situ in an existing building; this is consistent with the *avoided impacts approach* described in Section 2 of the Main Report. As impacts associated with in situ building materials occurred in the past and reflect a 'sunk cost,' they do not have any bearing on the current analysis. Only those materials associated with

present-day changes to an existing building, i.e., in the form of renovation and retrofit, and those associated with new construction, are relevant to this study.

Quantification Methodology

A thorough accounting of the materials used in each rehabilitation and new construction project was provided in order to complete the LCA analysis. Project-specific architectural and engineering drawings, specifications, and other documents were analyzed, allowing for the generation of a complete materials quantification take-off for each project. In the instances of the Vance Building and Block 49, drawings were unavailable and information was provided by third parties involved in the design and construction of case study buildings and utilized to quantify a significant percentage of the materials in the projects. Where estimate information and material quantities were received from third parties, it was necessary to verify the integrity of the information. In the case of the Vance Building, a field inspection was completed to accurately estimate the materials quantities used in the renovation. For Block 49, estimates were generated based on detailed measurements from drawings.

The LCA analysis relies on the weight or mass of construction materials in order to quantify environmental impacts. For purposes of importing the material take-offs into the LCA analysis, it was necessary to convert them into weight. This conversion utilized data from a variety of sources. For some materials, detailed information was available from MSDS or manufacturer information that defined unit weights of products. Typical unit weights of other systems—notably exterior glazing curtain wall, vertical transportation, mechanical, and electrical systems—were provided by subcontractors with experience in the design and installation of such systems and materials. For other materials, unit weights were accessed through other online sources, such as Penn State University Material Lab and manufacturer websites.

Once materials quantification and conversion into weight measurement were completed for each case study, this data was transferred into an Excel spreadsheet to allow data exchange, import, and analysis into the LCA model. The level of quantification was dictated by an industry standard[1] that is commonly used in the presentation and evaluation of construction projects.

The LCA analysis was performed by Quantis using the material quantities and weights developed by Skanska. All life cycle inventory data is drawn from the *ecoinvent* database v2.2. A detailed description of the LCA Analysis is found in Quantis' Technical Report and Appendices.

Many finished construction materials are 'complex' and contain several components. It was essential to account for the major components of each material studied, in order to accurately calculate the full impact of the material. The Excel template workbook used to detail the quantification results is able to proportion any single material quantity into three components for detailed analysis, by material type.[2] For example, the cabinetry installed in a project has many components that must be individually quantified before the environmental impact associated with the project can be understood. In the case of the study projects, the lineal footage of cabinetry was converted to a unit weight. Then, total weight was calculated based on the quantity represented in the documents and presented as three principal components: wood veneer material, plywood substrate, and chromium steel for hinges and other hardware.

As noted earlier, it was not possible to secure the same level of documentation of materials inputs for analysis and quantification for all of the case study projects. For several projects, mechanical and electrical design information could not be obtained. For these projects, interviews were held with design team members to generate necessary figures. In other cases, known values from fully detailed projects with similar mechanical systems were applied to case study projects. Because detailed design information was not available for quantification, there is a potential for uncertainty in the materials presented in the final analysis. Based on a review of the overall impact of these sections, however, these materials and systems are responsible for a relatively small percentage of overall material impacts.

The full list of materials included in the LCA analysis can be found in the Appendix (see Table A1).

Energy Efficiency Measure (EEM) Studies

A rigorous materials quantification process was completed for EEMs that were applied to buildings to improve energy performance. While such measures are designed to reduce environmental burdens, particularly carbon dioxide emissions, they also have environmental effects. It was essential to account for these impacts in the LCA analysis.

Notes have been provided within the template workbooks identifying various assumptions regarding the quantification of EEMs. In cases where an EEM is an entirely new system or set of materials, the Base Design calculations are credited (i.e., as negative values) and replaced with the alternate set of materials. To avoid double counting of materials, some EEMs are accepted as 'bundles' as the quantification associated with individual improvement measures are dependent on the completion of other individual efficiency measures . These have been coordinated with Quantis in the LCA process.

[1] Materials quantification is based on standards developed by the Construction Specifications Institute (CSI). The summary recognizes 16 Divisions of work for the materials analyzed..

[2] The project team determined that allowing for the breakdown of materials into three primary components would capture the vast majority of material impacts.