Achieving CLARITY

BY JOHN CROSS, PE

Transparency can be rather cloudy when it comes to evaluating the sustainability of building materials.

TRANSPARENT. ANALYTICAL.

If any two words could describe the major focus of building sustainability in 2016, it would be these two.

In response to a call for transparency by advocates of green construction, a large number of environmental product declarations (EPDs) documenting the environmental impacts of construction products have been published this year (and AISC has now published EPDs for fabricated structural steel products). At the same time, the growing availability of EPDs and the life-cycle inventory data behind them have fueled a greater push to evaluate project alternatives from an analytical through whole-building life-cycle assessments (WBLCAs) rather than attributional basis.

But the availability of EPDs and a push toward WBLCAs doesn't equate to full transparency and analytical decision-making. Let's look at those two items separately.

Transparency

There is more to an EPD than initially meets the eye. It would be nice to think that every EPD published by every product manufacturer is directly comparable to every other EPD in the marketplace. But that is not the case.

Different EPDs are often based on different declared units. Some product manufacturers may choose to state the environmental impacts of their products based on volume (tons of CO_2 per cubic yard of material) while others go with a square-feet-of-constructed-area basis (tons of CO_2 per square foot) and yet others a per-square-foot-of-material (tons of CO_2 per board-foot) basis. In the case of structural steel, the EPDs published by AISC document impacts on a tonnage basis (tons of CO_2 per ton).

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Within a particular product family, such as steel, a product category rule (PCR) is established to assure that all product category EPDs are based on the same declared units and report the environmental impacts in a consistent manner. The PCR for steel requires that all steel EPDs report impacts based on a declared unit of "one metric ton of steel construction product" (sorry, EPDs are governed by an ISO standard that requires the use of metric units). But even a common declared unit does not guarantee comparability. A ton of cold-formed steel sections does not have the same engineering and load bearing properties that a ton of hot-rolled structural steel has, and it is therefore impossible to do a direct comparison between different steel products even if they are all covered by the same PCR.

And it is not just the unit type used to determine environmental impacts that limits comparability. The scope of the EPD can also vary. Different EPDs may track impacts up to and through different product stages. Some EPDs are only consider impacts through the manufacturing stage of the base material, others include impacts through offsite fabrication, some include the construction stage and others calculate impacts during the use stage of the product and some attempt to achieve a full cradle-to-cradle perspective and include the end-of-life stage. Which approach is correct? All of them and none of them. The fact is that to compare EPDs, the product stages being compared must be consistent.

This is particularly tricky for products that are fabricated offsite like structural steel. There are EPDs based on the material produced at the mill—i.e. "hot-rolled structural steel" and there are EPDs for the fabricated product as delivered to the project site—i.e. "fabricated hot rolled structural steel." To satisfy the requirements of rating systems like LEED, the EPD that is submitted for a project must be for the product as delivered to the project site. So in the case of steel, this means fabricated hot-rolled structural sections, plate or hollow structural sections (HSS).

But even that isn't a fair comparison to other materials that are assembled or built on-site. Why should the fabrication impacts for structural steel be included when the on-site construction activity required for concrete and wood are not? The bottom line is that EPDs are good information that is required for project documentation by rating systems like LEED, but they should not be used to compare products or materials.

At this point, there may be a question floating around in your mind… If AISC has published EPDs for fabricated structural steel products, why isn't there a table in this article listing what the impacts are for a ton of fabricated hot-rolled shapes, a ton of fabricated HSS and a ton of fabricated plate? Well, no such table exists, nor will it. The data is there and the EPDs are published, but if a table was included in this article, most readers would immediately go to the table and conclude that the environmental impacts of fabricated hot-rolled structural sections are less than the impacts for fabricated plate or fabricated HSS. And they would be wrong. A ton of hot-rolled sections is not the same as a ton of plate or a ton of HSS. You cannot make a comparison on an impact-per-ton basis. If you want to see the impacts, you can go to **www.aisc.org/epd** and download the appropriate EPD and look at it only the context of that product.

Analytical

So what is the solution?

The green community has long dreamed of an analytical approach for comparing the overall environmental impacts of a building. That dream has been captured under the label of WBLCAs, which look at the quantities of all the products used in the construction of a building then add them up to determine the overall environmental impact of the building. The goal is then to compare the final building design to that of the same building designed using an alternative approach and show improvement in the level of the impacts. Such a process is now memorialized in ASTM Standard E-2921.

This is great in theory, but for accurate comparisons to be made in a WBLCA, certain factors must be in place:

- Accurate environmental impact data must be available for all products
- The methodology for determining the impacts must be consistent
- All environmental impact categories must be considered, not just a select subset of categories
- The product stages of the impact data must be consistent
- Product quantities for both the final design and the comparative structure must be accurate, not rough parametric estimates

The fact is that in most cases, WBLCAs currently fail on all counts.

Accurate environmental impact data is often not available for the products being used for the project. While many EPDs have been published and the background data from these EPDs has been entered in impact databases, the impact data remains suspicious. For example, EPDs issued by the wood industry are based on the assumption of sustainable forest management and harvesting practices, yet less than 20% of the timber harvested in the United States meets those requirements.

Different products may follow different methodologies for the calculation of the impacts. For example, the concrete industry ignores the environmental impacts of mill slag used as a cement substitute while the steel industry takes a credit because the material is a co-product being used in another process. Who's right? Both of us and neither of us.

And what impact categories are being considered? The push toward environmental impact categories was based on the argument that categories provide an analytical view of overall product impacts rather than simple identifying a single product attribute. Steel is a highly recycled product, concrete is regionally produced and wood is bio-based—all of which are attractive attributes—but it was argued that products should not be chosen based on a single attribute. Instead, a product should be evaluated on its overall environmental impacts. Yet the wood industry has resisted any attempts to include a wide range of impacts such as land use, resource consumption and biodiversity in WBLCA criteria, limiting the analysis to only those categories that would be associated with a bio-based product. This sleight-of-hand transforms what is intended to be a comprehensive view of environmental impacts into a disguised single-attribute evaluation.

Comparisons that are made without considering the use stage of the product also miss the mark. Structural steel framing systems do not require replacement or rehabilitation during their life, yet wood and concrete systems may require a greater level of maintenance during the same building lifespan. Accurate WBLCAs must take these differences into account.

And finally, any accurate WBLCA comparing two structures must have accurate material quantities for each alternative. Estimates don't work when it comes to structural quantities. Steel tonnage and concrete quantities are not calculated in the same way as carpet square footage. Load requirements must be known, span lengths optimized, seismic conditions taken into account.

Does this mean that the structural system for both buildings (the proposed building and the alternative to which it is being compared) be fully designed? The simple answer is yes—while probably not to the level of construction drawings, certainly well beyond concept or schematic drawings. An immediate objection is raised that this will be a costly process and that project budgets will not be adequate to cover this cost. That is certainly a concern, but the solution isn't to dumb down WBLCAs to the point where they produce meaningless results, but rather to treat them as a critical decision-making tool in the design process.

Most rating systems and standards require that the chosen alternative demonstrate a minimum of a 5% improvement in several impact categories compared to the building alternate. But parametric and early design estimates of materials typically vary by as much as 20%. What level of confidence can exist in the results of a WBLCA if the basis of the calculations varies by 20%? Certainly not enough to justify a decision based on a 5% improvement in impacts.

So…

So do we throw up our hands, give up and declare both transparency and WBLCAs a fool's errand? No. Environmental-impact transparency and WBLCAs should be critical decision-making tools in the design process. But the design industry is faced with a dilemma. Are EPDs and WBLCAs dumbed down by accepting incomplete, inconsistent and inaccurate input data, or are they elevated to serious science? Or will project owners and design professionals demand rigorous transparency and WBLCAs, recognizing the costs associated with them? In one case it is garbage in, garbage out. In the other case a meaningful approach to addressing the environmental challenges of the 21st century is to do so by seeing clearly and knowingly. ■