Expert Tips

Developing a Functionally Equivalent Design for Comparative WBLCA

Identify what is required for two or more building designs to be compared to each other.

Design teams are often interested in using whole building life cycle assessment (WBLCA) to study the differences between mass timber buildings and more conventional steel or concrete buildings. When making these types of comparisons, it is important to ensure that the design alternatives being compared are *functionally equivalent*.

Specifically, consider the following:

- **Do the buildings have the same occupancy/use?** The occupancy and use of the building affects the allowable building size, required level of fire protection and what materials are permitted. It also affects the overall configuration of the building, structural loads that need to be applied, and many other aspects of the design.
    - *E.g., it would not be appropriate to compare an office building to a multi-family residential building.*
- **Are the buildings roughly the same size (floor area, height, number of stories above and below grade)?** LCA results are often presented in terms of impact per unit floor area (/m^2 or /ft^2). While these normalized results do help in making comparisons, the buildings themselves should still be similar sizes. Larger/taller buildings may have relatively larger impacts due to increased demands on the lateral system, foundation system, etc. Projects with below-grade construction will also often have larger relative impacts than structures that are entirely above grade.
    - *E.g., it would not be appropriate to compare a three-story building to a 12-story building with below-grade parking levels.*

- **Are the structural hazards (e.g., wind, seismic, snow) and structural design loads the same?** Buildings with higher load demands will typically require more structural materials due to increased demands on the structural systems (gravity, lateral, foundations, etc.). In particular, buildings in high seismic regions tend to use more material due to more stringent load and detailing requirements, resulting in higher LCA impacts.
    - *E.g., it would not be appropriate to compare a building in Los Angeles, a high seismic region, to a building in New York City, a region of low seismicity.*
- **Are the buildings designed to the same codes and standards?** Different jurisdictions adopt different building codes, typically based on different versions of the IBC with or without amendments. There can be significant changes with each code cycle that can affect the amount or type of material that is required.
    - *E.g., it might not be appropriate to compare a building in a jurisdiction that has adopted the changes to the tall wood construction types from the 2024 IBC to a building in a jurisdiction that has not adopted these provisions.*
- **Are the buildings expected to have the same service life?** The service life of a building primarily affects operational impacts that accumulate over the building's lifetime. When looking at embodied impacts, the service life of the building will dictate how often certain materials need to be replaced over the building's lifetime. All structural materials should be designed to last the life of the building, but non-structural materials may need to be replaced. While these embodied impacts are often minor, significant differences in the service life of the buildings can make it challenging to make comparisons.
    - *E.g., it might not be appropriate to compare a building with an expected service life of 60 years to a building with an expected service life of 100+ years, especially if operational impacts are included.*
- **Are there any other unique features of the buildings that would prevent an accurate comparison?** Some projects have unique design requirements that go beyond what is required by the code. This can include an owner's desire for improved thermal, acoustic, or vibration performance. Other projects may have unique design features set by the owner or architect which can result in a more complex design. These types of unique design features can result in more material being used and higher LCA impacts.
    - *E.g., it would not be appropriate to compare a rectangular, box-style structure to a structure with curved walls and roofs, large cantilevers, vertical offsets, etc.*

To meet all of the above considerations, most design teams develop *project-specific alternative designs* for use in comparative WBLCAs. While many project teams express interest in comparing to "similar" projects within their portfolio or even to industry benchmarks, ***using a project-specific redesign is the preferred approach as it provides the most apples-to-apples comparison***.

When developing a project-specific alternative design, it is important to note that there can still be differences between the designs. For example:

- Construction type may vary based on the building materials that will be used. For example, it may be appropriate to compare a Type IV mass timber building to a Type I or II steel or concrete building. Selection of construction type will have an impact on the fire protection that is required, including fire-resistance ratings,

sprinkler requirements, materials that are permitted to be used, etc.

- Grid spacing may vary based on the optimal span of each material.
- Floor-to-floor height, floor-to-ceiling clear height, and/or overall building height might vary, depending on the thickness of the floor-ceiling assemblies that are chosen to achieve fire, acoustic, and aesthetic objectives with each material.
- The lateral system may vary based on the material used for the gravity framing system, which can affect the overall weight of the building and dictate what lateral systems are most appropriate.
- The foundation system may also vary based on the material used for the gravity framing system because of the impact that it has on the overall weight of the building and the design of the lateral system.

These considerations and more are outlined in the Considerations and Worksheet for Structural WBLCA of Mass Timber Buildings paper. The accompanying standalone WBLCA Worksheet is a useful tool to keep track of the constants and variables among the different design alternatives.

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