Embodied Carbon Intensity Diagram Primer

Introduction

The embodied carbon intensity diagrams are meant to be an educational resource included on the SE 2050 website. The intent is for the SE 2050 Working Group to create diagrams for typical framing schemes for various building use types. Each diagram will include the following information:

- Structural framing scheme (ex: concrete flat slab, composite steel deck, etc.)
- Use type (ex: residential, office, etc.)
- Bay scheme diagram
- Applied loading
- Material strength and reinforcement criteria, as applicable
- Design criteria
- Structural material quantities (SMQs)
- Life cycle assessment assumptions
    - What is included or excluded
    - LCA sources/tools used
- Range of embodied carbon (global warming potential) intensities, in kg CO_2e/m^2 and lbs CO_2e/ft^2

To create these diagrams, volunteers will complete the following tasks for each diagram:

1. Design framing scheme
2. Determine SMQs or create Revit model
3. Determine embodied carbon (EC) intensity

Note that individual volunteers need not complete all three tasks. This primer is meant to outline the anticipated work associated with each of the steps above, as a guide to volunteers.

1 - Design Framing Scheme

For each diagram and scheme considered, the goal is to have at least three volunteers determine a structural framing design. This creates a range of designs that represents some of the variability associated with differing engineering practices and methods, including the use of different software programs.

For each scheme, volunteers will reference the appropriate Scheme Layout to complete their designs using specified bay geometry, loading, materials, and other design criteria. With this as the stated design problem, volunteers will determine a design solution.

Although the structural material quantity (SMQ) is for one interior bay only, engineers should design the bay considering one additional bay on each side to provide some continuity at the bay's perimeter. The design geometry, then, should consider a 3x3 grid of bays, see Figure 1. Note that the focus of the design and SMQs is the interior bay only. Potential design deficiencies outside of the middle bay may be ignored (e.g. in the post-tensioned concrete scheme, the thickness of the slab should not be controlled by deflection criteria or punching failure at the outer bays).

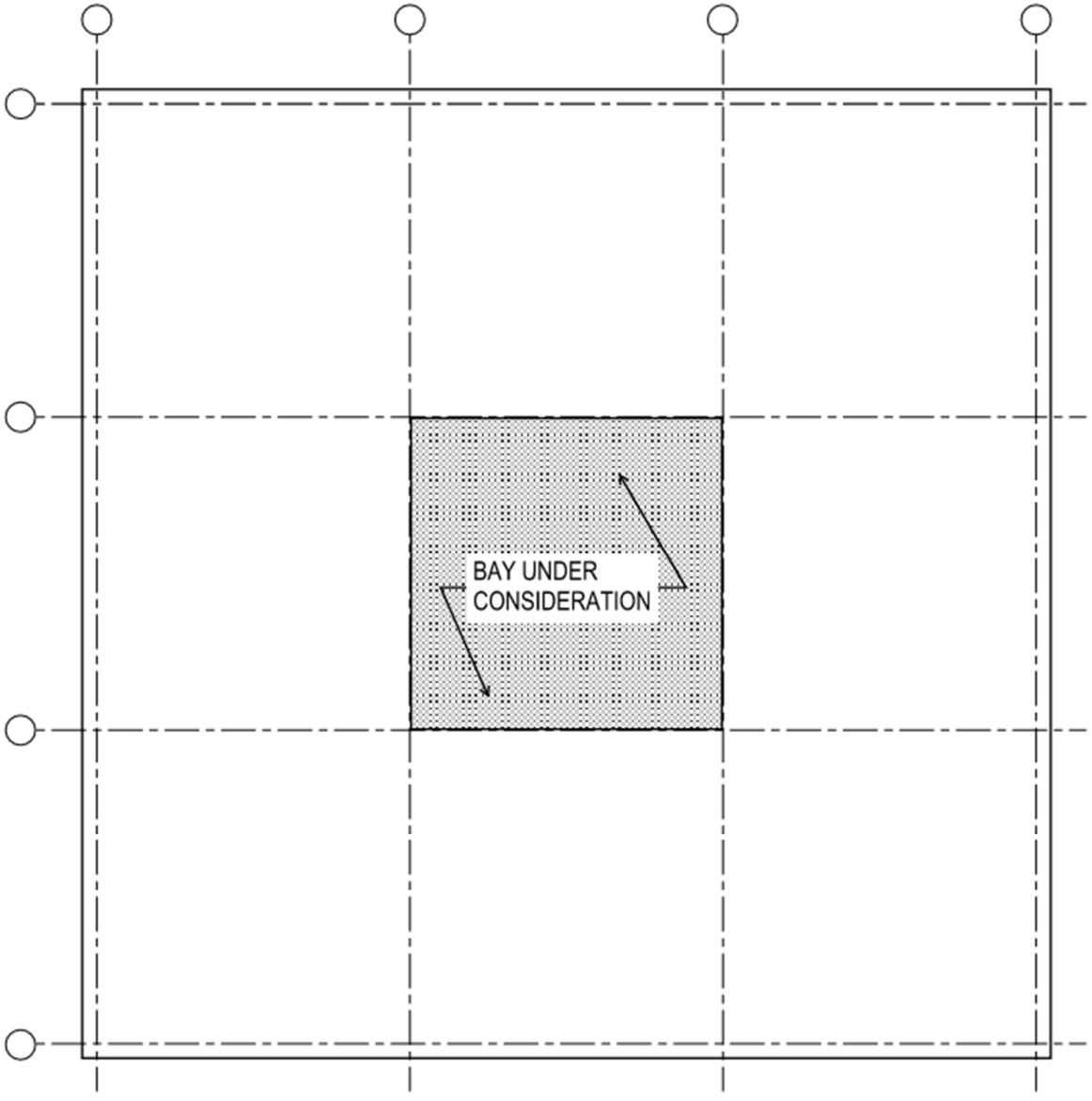

Figure 1 - 3x3 Bay Grid

2 - Determine Structural Material Quantities

Once a design solution has been determined for a scheme, design volunteers will fill out the yellow boxes contained within the associated Scheme Layout. From these inputs, a material quantity take-off to determine SMQs can be done. All structural materials within the bay should be considered for the LCA, with the exception of columns.

Material quantities should be for a single, interior bay only. For framing members at the perimeter of the bay, half the quantity of these members should be included in the take-off, see Figure 2.

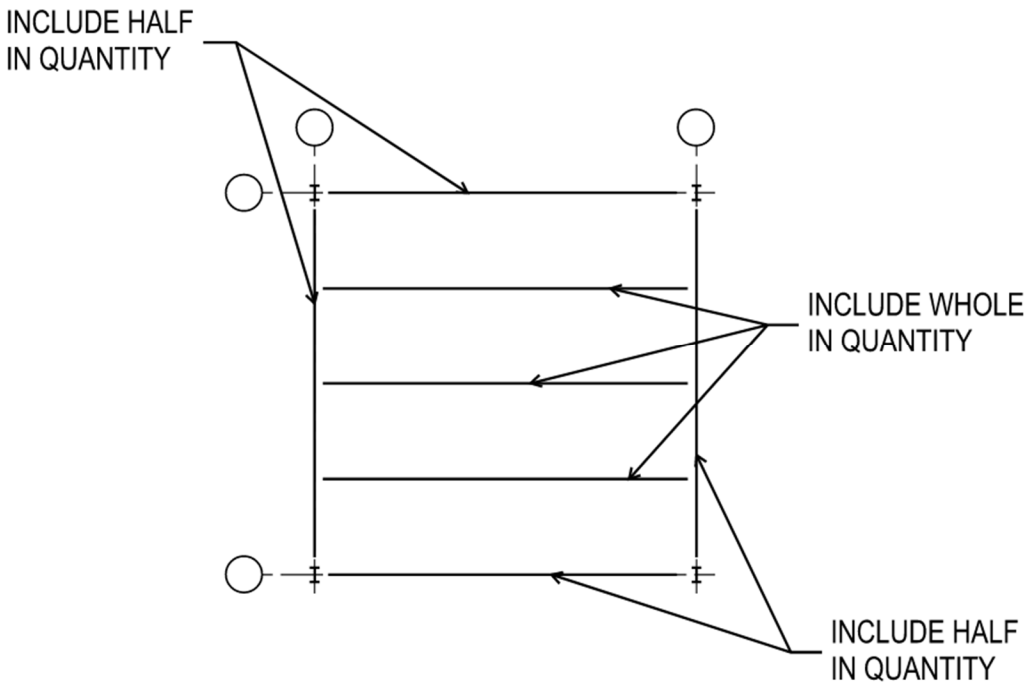

Figure 2 - Elements at Perimeter

In lieu of a hand take-off of structural material quantities, a representative Revit model can be created. The model should consider the same inclusions and exclusions as noted above and within the appropriate Scheme Layout.

3 – Determine Embodied Carbon Intensity

After designs have been determined and SMQs have been collected, volunteers will need to apply LCA data to determine the GWP for each diagram. Volunteer bay designers do not need to calculation their design's GWP. Separate volunteers will use Tally, Athena, and OneClick to calculate the embodied carbon for all designs to maintain consistency in approach. The GWP will be divided by the bay area to determine the embodied carbon intensity, in kg CO_2e/m^2 and lbs CO_2e/ft^2.

Appendix A: Example Embodied Carbon Diagram