# The Differences in how we build: Material use and intensity in small multi-units' Buildings in Brazil, Canada, Greece, Nigeria and Switzerland

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***Summary***

The growing global population is increasing the demand for housing at the same time as the ecological limits requires much more resource-efficiency. Small multi-unit buildings are regularly proposed to increase material efficiency in housing construction. However, there are many ways to design and build buildings; which are the most materially efficient and what are the factors that increase material use? This paper quantifies material use and intensity (MI) in small multi-unit buildings using real world examples from 5 countries (Brazil, Canada, Greece, Switzerland and Nigeria) on 4 continents. We study buildings with 3 to 35 units built between 2014 and 2024. Overall, this study examines drivers of MI and how they vary (or not) within the 50 case study buildings.

When we compare the material use and intensity (MI) by floor area (per square meter), there's a 20% difference. But when we compare by units, the difference is much bigger, about 150%. This is because some units are larger, have more bedrooms, or use space differently than others. Concrete use is dominant across countries with structural concrete making up 55% of the total material mass and concrete unit masonry 20%, representing 75% of the material mass across sampled buildings. Floors, decks, slabs, and exterior walls contribute heavily to this proportion but with large variations between countries. The work provides needed geographical diversity to our understanding of MI and understanding of how norms on space use influence MI.

**Main Insights**:

**Design and structural influences on MI**: Approaches to building design, such as bedroom size, bathroom numbers and foundation types have an impact on material use. For instance, Canada's buildings feature large foundations (33% of material use by mass), while countries like Switzerland have a relatively high use of concrete and masonry, with underground parking in these relatively small buildings further increasing MI in the studied buildings.

**Design modifications can reduce MI**: Reducing bedroom sizes, minimizing underground parking, and cutting down the number of bathrooms can lower MI by 20-35%. Efficient designs with fewer partitions and lighter finishes also contribute to lower material footprints.

**Impact of regional construction practices and climate on material use**: Regional construction practices impact material use and intensity (MI), with variations driven by factors such as security concerns. Countries with heightened security needs such as Switzerland and Nigeria showed higher MI (mean of 1,400 kg/m²) compared to those without such concerns (mean of 800 kg/m²). Local climate was also found to be a weak but real driver of material use.

This study demonstrates the influence of approaches to space (e.g. unit and building size, bedroom and bathroom count), security, and material selection to resource use and highlights design decisions and norms that increase/decrease resource use.

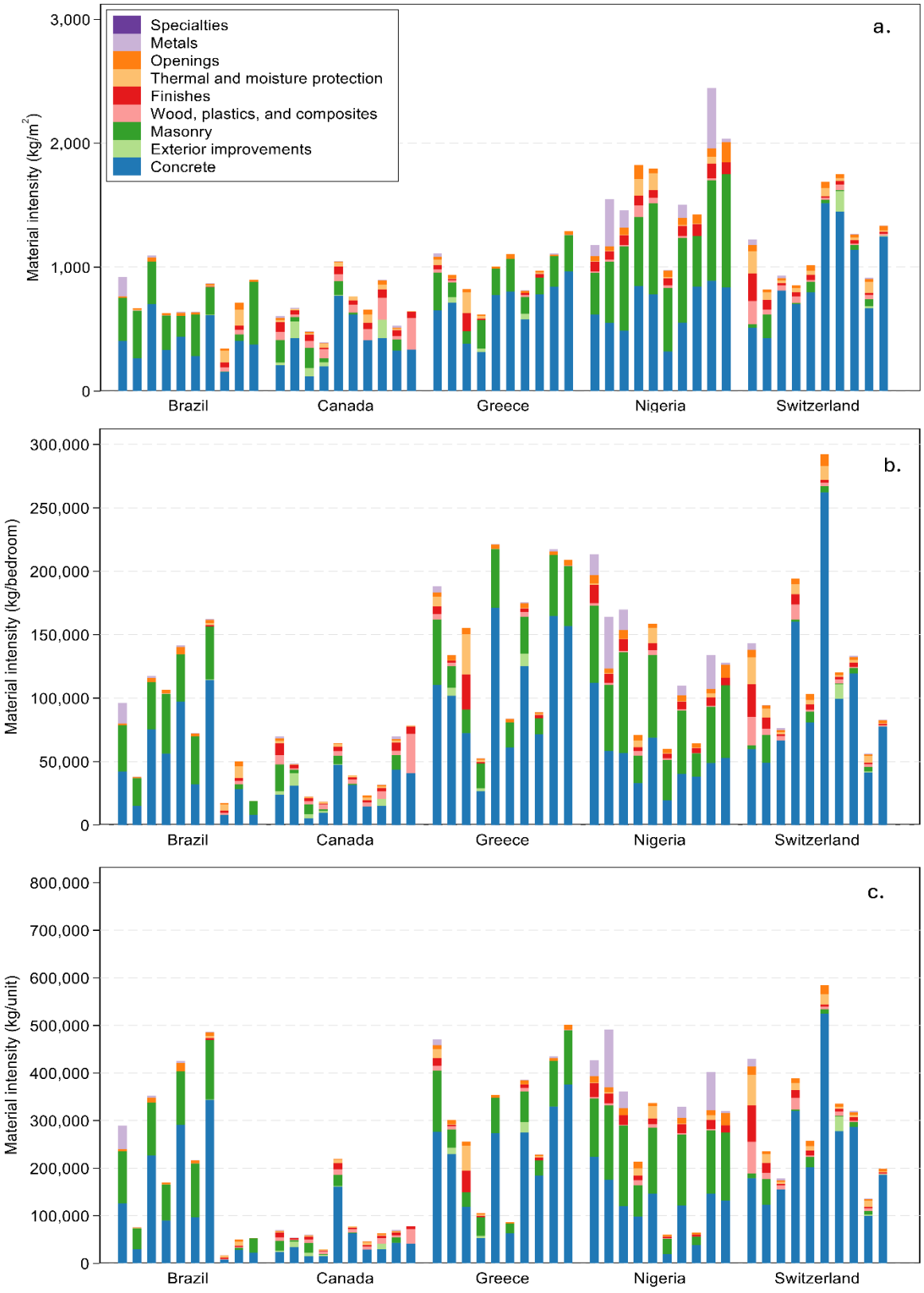


**Figure 1** - Figure 2. Material intensity (MI) on a mass basis for 50 small multi-units' buildings in Brazil, Canada, Greece, Nigeria and Switzerland on a) $1m^2$ gross floor area, b) Per Bedroom, and c) 1 per unit functional unit bases.