WT - Material and Resources

One of the aspects to which we attribute more importance in the design of a building is the material choice. What one builds the exterior envelope of their space with affects its ability to breath (important for preventing sick building syndrome, an affliction to buildings often caused by mold, dust, and volatile organic compounds which can cause sickness in a buildings occupants), to retain temperatures, the embodied energy cost of a building, its longevity and its strength against earthquakes, etc. Today there are a variety of materials to choose from that meet these goals.

Wood is a good option because it is a material that is known and there are often prescribed codes for building with it (thus reducing engineering costs). Wood buildings generally breath well, do not have high embodied energy (1380 MJ/m3), can last for hundreds of years, if well taken care of, and have a high tolerance to earthquakes. Wood framing on its own however does not insulate well and thus must be supplemented with some type of insulation. Wood's disadvantage is its lack of inherent insulation, its susceptibility to weather if not properly protected and its high flammability. When we choose wood for a project, we consider wood that is FSC certified. The FSC (Forest Stewardship Council) is a nonprofit certification group that ensures the "responsible stewardship of the world's forests" ("Forest Stewardship Council").

For larger buildings and those that require higher strength materials, steel becomes a viable option. While much more expensive than wood, steel offers great tensile strength. Like wood, it is susceptible to degradation without protection and must be supplemented with insulation. Also, steel can create a thermal bridge between the outside of a building's envelope and the interior. Because steel is a conductor, unless it is insulated on both sides, steel conducts heat rapidly, and degrades the quality of one's envelope. Steel also has a very high embodied energy of 251,200 MJ/m3, 182 times as high as. Steel it seems then, is only suited for applications where strength is of the utmost importance; in other cases, the negatives of using steel far outweigh the positives. If steel is used, using recycled steel is often the most sustainable option and it is readily available.

Another material that is used quite often in buildings today is concrete. Poured concrete with rebar offers a reasonable amount of insulation (although we often suggest supplemental insulation), has a reasonable embodied energy (3180 MJ/m3), is structurally stable, resistant to earthquakes and has great longevity ("Measure of Sustainability: Embodied Energy"). A disadvantage of poured concrete is that it is hard to recycle or reuse. One benefit specific to concrete is its high thermal mass, which makes this material perfect for sun rooms.

Straw Bale is an interesting material that has been used for a long time to build homes but is seen as an alternative building material today. Oftentimes, straw bale is used as wall infill in conjunction with wood framing to be sure of its stability. In this case the bale acts as a renewable and inexpensive insulation. New research and engineering is now allowing straw bale to be used structurally in cities (though it's been used structurally successfully for over one hundred years without engineering).

By putting rebar through the bale and coating it with stucco, it becomes reasonably earthquake resistant and can be used in multistory buildings. Straw bale, while having a very low embodied energy (it is often considered a waste product), is a great insulator, and is highly breathable, has a few issues that must be addressed if building with it. Because bale creation is often unregulated, seeds and nutritional parts of hay may be left in straw bale. This can attract local insect populations that may take up residence in the bale and cause it to become unstable. Mixing borax with bales can help to prevent infestation (Steen et al. 46-47).

Another risk with straw bale is its susceptibility to weather. Wet straw bale will rot quickly and become a major problem for a building's stability and air quality. Thus great care must be taken to protect the bale with overhangs, siding, and/or stucco.

Rammed earth (literally earth that has been packed into a form, similar to adobe bricks except walls do not contain individual bricks), another alternative material, has been successfully used by many cultures for centuries. It is very similar to concrete in its thermal properties, however its impact on the environment is much less. Engineering on rammed earth structures has not been done for tall buildings and currently is most likely not well suited for them. Rammed earth is also much more susceptible to erosion from rain than other materials and requires a large amount of labor. If doing the labor by hand, and enough soil is available locally, rammed earth is a material that has one of the lowest embodied energies one can find. Rammed earth can also be supplemented with tires or bottles to make an earthship (compacted earth is placed in the tires, but not the bottles, as the air in the bottle provides good insulation). This has the added advantage of using a waste material in your building and reducing the amount of dirt and therefore compaction necessary.

There are two materials that are currently taking the green building world by storm. SIPs (Structural Insulated Panels) and "Green" CMUs (Concrete Masonry Units, also called cinderblock) are both composite materials that are meant to be easy to build with and provide environmental benefits over traditional materials. SIPs are essentially a sandwich of a structural member, an insulating core and another structural member. Because the SIP replaces several building components (insulation, studs, joists) of a traditional wood frame building, it makes building with it far easier. This is the main advantage of building with SIPs. "Green" SIPs use FSC certified wood for the exterior structural membrane, and often a renewable resource such as straw or soy for the insulation in the panel. SIPs embodied energy cost is similar or a little higher than standard wood framed buildings and are often more expensive than other building materials but savings in labor can make up the cost.

Because insulation runs the course of a SIP, it provides slightly tighter building envelope and thus higher R-values than wood framing combined with insulation (unless spray-in foam is used). SIPs also outperform traditional framing structurally. Most commonly, SIPs are used in combination with wood framing; framing is used for a building's walls and SIPs are used for the roof. When we choose "Green" CMUs, we have a variety of options. CMUs already have the advantage of being easy to build with, the cinderblocks are stacked, rebar is placed in the holes and concrete is pored to create a column. CMUs that are deemed to be more sustainable are even easier to build with because they are lighter. The blocks are formed by mixing recycled waste wood, which has been mineralized (like petrified wood) or polystyrene beads, with cement. Some CMU manufacturers also fill part of the CMU's cavity with insulation such as rock wool or polystyrene, greatly increasing its R-value. "Green" CMUs are long-lived, breath well, have a relatively low embodied energy (much less than a traditional CMU which has an embodied energy of 2350 MJ/m3) and are structurally very strong ("Measure of Sustainability: Embodied Energy"). The disadvantages of green CMUs are that they can be relatively expensive, and currently are not often available locally so transportation costs may be great.

It is of utmost importance to choose the proper material for a given building. One should not be limited to choosing just one, however. Oftentimes materials will be mixed in a well designed space; for example, steel offering support in areas where strength is required, wood framing used in an outdoor room where insulation is less important, and insulating CMUs used for the majority of a building.