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Composite Materials in Architecture

The field of architecture is one that could change in an instant. Materials, technologies, and process are constantly improving and advancing; but old technologies are used today just as often as a material that was invented yesterday. As quickly as material science develops, architecture takes hold and pushes it to a new height. Before, buildings were created from anything builders had on hand but due to the versatility and attributes of early composite materials, engineers and architects were able to begin pushing the boundaries of what was possible.

Composite material is a broad term used to describe an attempt to take advantage of the beneficial attributes of dissimilar materials by synthesizing the two into one. This means any material that is created by combining one substance for holding shape and another that typically forms around the previous to bind it all together can be considered a composite material. The romans first invented the idea of material science when they invented a mortar type substance to sure-up stone construction, but mud bricks are considered to be the oldest composite material going back to the beginning of society. Today, the concept is the same used in the creation of many materials that are considered to be on the cutting edge of science. Fiber Reinforced Polymer, Glulam, textile membrane, and composite decking are all common examples of composite materials. Due to the increased durability of these composite materials, they can perform their function many times longer than traditional materials.

Pictured below is a man putting mud mixture into the rectangular mold for making bricks. These bricks will sit in the sun until they are mostly dried out. (source: BBC news)

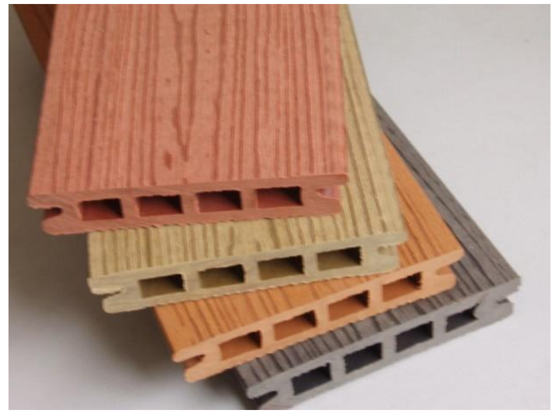
Producing mud bricks is a simple, but laborious process. A mixture is created by combining mud, sand, or other frictional soils with something to hold it together such as straw or long grasses. This mixture is then placed in a mold and dried by the sun or in a kiln. The finished product is a viable building material, so long as it does not get wet. This problem was often solved by either heat curing the bricks or covering them in stucco, which is naturally resistant to water. With these bricks, ancient were able to not only build shelters for themselves but mosques, ziggurats, and even palaces.

Glulam is a composite made of wood and extremely strong bonding adhesive. This is perhaps one of the most natural solutions to composite materials as they are constructed mainly of wood. These structural beams work by using multiple pieces of wood to span huge distances that would be impossible for one singular beam. The process of making glulam beams is simple. Wood is bonded in stacks using extremely strong resin based adhesives and manufacturers even stagger pieces of wood to prevent the final product from having any discernable weak points. The fibrous wood fuses well to resin adhesives and works together to create a strong singular beam that is now massive, but offers exponentially stronger force resistance and even some fire resistance. These beams have been used in construction of everything from ice arenas to church sanctuary's as they can be built to nearly any dimension and strength.

Above is depicted a woman applying sealant to a beam that has already been assembled. Note how the beam is just a composition of layers of dimension lumber. (source: gate-project.org)

Wood-Plastic composite is the technical term for composite decking. Straying a little further from natural solutions, these durable and water-resistant boards are made by combining finely ground wood and a thermoplastic; a group of plastics that includes PVC. After the plastic hardens, the resulting product is stronger than any wood boards of the same size and they will last nearly twice as long with no maintenance. These boards are used outdoors in porches and decks, so the addition of insect, water, and rot resistance is a vast improvement on the traditional wood boards. Traditional wood also requires regular maintenance of painting every year or two, depending on its use and wear which is one cost this composite material can save over time. The plastic can be dyed to any color or have any number of additives that grant it extra strength or resistance to degradation.

Below are a few examples of wood plastic lumber. They are made to slot together and after installation can often be indiscernible from real wood boards. (source: appropedia.com)



Above is Jacobs Pavilion, in Cleveland. This tensile structure forms a shelter for the amphitheater inside. Tensile membrane structures can easily be grasped by picturing a circus tent. (source: davidgray.com)

Textile membrane is a durable, flexable, lightweight solution to outdoor shades, awnings, and roofs. Most of these tensile structures are made of polyresin coated fiberglass mesh or PVC coated polyester mesh. Both of these types of membranes are waterproof due to the sealing agents, making them a popular option for covering large outdoor areas for amphitheaters or pavilions. Putting up the tensile structures is relatively simple because they are such a light weight material and rarely require more than a few anchor points to keep erect. Compared to traditional solutions to similar problems, tensile membrane structures are a cost effective and sustainable option.

Fiber reinforced polymer is perhaps one of the most promising and underutilized composite materials. It is created by combining a polymer resin with glass or carbon fibers to create an extremely durable, versatile, and water-resistant material. Because it is a liquid that sets over time, it can be painted onto forms or cast in molds. Today, FRP paneling can be applied to fire-resistant systems to achieve some safety from flame or fire retardant additives can be mixed into the resin; in addition, the plastic component can be made any color or variety of finishes. The water-resistant nature of FRP makes it a great option for areas with high moisture, or exterior applications. The strength and durability makes it a suitable replacement for drywall or wood solutions to wall coverings, even more so due to the water resistance. The flexibility of FRP enables it to become or serve just about any function in a building system. Just like wood can manipulated into just about any shape or form, FRP follows suit. Applications range from wall systems, facades, connectors, insulators, sun shades, and much more.

Perhaps the most powerful example of what composite materials can achieve; the most recent addition to the SanFran MOMA. The façade is entirely made of FRP. (source: notey.com)

Whether architecture continues to synthesize and implement composite materials or not, they have certainly made a mark on the industry. Composites are stronger, more durable, and often offer water and insect resistant qualities. The best advantage of the composite material market is the lightweight nature of the resulting materials. This quality alone has helped to develop countless new process and systems for the modern face of architecture, making composite materials a highly likely gateway to the future possibilities of what architects and designers will one day be able to achieve.