International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 6 June 2021, pp: 563-569 www.ijaem.net ISSN: 2395-5252

Building Materials: A Comparative Analysis

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Submitted: 25-05-2021 Revised: 01-06-2021 Accepted: 05-06-2021

ABSTRACT: Construction industry is one of the fastest growing industry in modern era, construction of structures is need of developing and developed countries but construction of any building or human oriented structure, need materials, without material construction is impossible and without true knowledge about material construction is base less because material defines the nature of structure for example if you need a rapid construction then material required for construction is different from ordinary construction material. A number of different materials are available, but knowledge about which one is better to use and where to use? Is important. Without right knowledge, it creates a blunder because constructing a building structure is not a child's play. Nowadays some Architects and contractors use the materials as on their aesthetic looks and margin the found from companies but they don't check is it right to use? Using materials without knowing their impacts can be harmful. So, we can avoid these mistakes, the aim of this research paper is to give proper knowledge of materials, their properties and construction techniques, and where they are suitable to use. Also, the materials we are using whether they have a critical environmental effect or not. Are they economically suitable to use or not? The answer to these questions is here in this research paper.

Keywords: Building materials, Construction Techniques, Material property, Impact of material on environment.

I. INTRODUCTION

There are different building materials for constructing buildings and also having different techniques. As we know there are lots of materials are available but some have a critical environmental effect which is not good for us. The use of materials without knowing their impacts always gives bad results. People use materials of another climatic zone. Why? Because it looks pleasing and aesthetic in look and it helps them to show richer in society. These reasons are illogical because only for show off you cannot destroy the environment and also the health of others and also, it is not economically suitable.

II. METHODOLOGY

Method and analysis which is performed in your research work should be written in this section. A simple strategy to follow is to use keywords from your title in first few sentences.

Building Materials

Building material may be defined as any kind of raw materials which can be used for construction work of any type of building say houses. The most common types of building materials used in the construction industry are bricks, cement, aggregate, wood, metals, concrete, glass, etc. One can choose between the type of building construction material to be used in a building based on cost-effectiveness for building projects. Many kinds of naturally occurring substances such as clay, sand, wood and rocks, stones, etc. can be used to construct the buildings according to their effectiveness. Along with the naturally occurring material many kinds of man-made products are also used, in which some may be more synthetic, some less. The manufacture of building materials is an established industry in many countries, such as India being one of the top producers of cement and the use of these materials is typically segmented into specific specialty trades, such as carpentry, plumbing, roofing, and insulation work.

Types of Building Materials Used in Construction Work

- **Naturally Occurring Construction Materials**

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- Construction materials are generally classified into two sources which are natural and synthetic type of building construction material. Naturally occurring building construction materials are those which can be used unprocessed or minimally processed by any industry, such as lumber(wood) or glass. Synthetic materials are made in industrial settings after much human manipulations, such as plastics and petroleum-based paints, etc. Both have their specific uses according to the effectiveness needed for the building project. Mud, stone, and fibrous plants are the most basic materials, aside from tents made of flexible materials such as cloth or skins. People all over the world have used these three materials together to create homes to suit their local weather conditions. In general stone and/or brush are used as basic structural components in these buildings, while mud is used to fill in space between, acting as a type of concrete and insulation. A basic example is a wattle and daub mostly used as permanent housing in tropical countries or as summer structures by ancient northern people. There are many such examples where the naturally occurring materials have served as a shelter for the nomadic people or our ancestors before the man-made synthetic building construction materials were produced or manufactured.
- **Fabric**

The fabric is one of the most common materials to make tents by the early nomadic people of not only our country but all over the world. There are two very renowned types of tent construction techniques which include the conical tepee and the circular yurt. The development of tensile architecture and synthetic fabrics has revived the use of fabric as an effective building construction material. Modern buildings can be made of flexible(tensile) material such as fabric membranes, and supported by a system of steel cables (tensile structures) or internal (air pressure: pneumatic structures).

- **Mud and clay**

The different styles of buildings come out from the different proportions of materials used for the construction of it. It also depends on the quality of the material or soil being used. The cob/adobe style usually uses a large amount of clay, while sod buildings can be constructed with a low amount of clay. The other main ingredients include more or less sand/gravel and straw/grasses. Rammed earth is both an old and newer take on creating walls, once made by compacting clay soils between planks by hand, now forms and mechanical pneumatic compressors are used. Soil and especially clay is good thermal mass; it is very good at keeping temperatures at a constant level. It acts as an insulation from extreme weather or climatic conditions. Homes built with earth tend to be naturally cool in the summer heat and warm in cold weather. Clay holds heat or cold, releasing it over a period of time like a stone just as water does in the case of land breeze and sea breeze due to its high specific heat capacity or thermal heat. Earthen walls change temperature slowly, so artificially raising or lowering the temperature can use more resources than in say a wood-built house, but the heat/coolness stays longer. People's buildings with mostly dirt and clay, such as cob, sod, and adobe, resulted in homes that have been built for centuries in western and northern Europe as well as the rest of the world, and continue to be built, though on a smaller scale. Some of these buildings have remained habitable for hundreds of years. This is a clear indication that the naturally occurring building materials used over the man-made synthetic manufactures have been proven more effective since earlier times.

- **Rock/stones**

Rocks are the basic source of stones. Rocks are present in the environment after a series of various environmental processes. The qualities of stones depend on the rock source from where it is obtained. To know about stones in detail we need to know about rocks also.Rocks/stones are the ancient building or sheltering material since earlier times. It is very long-lasting and is usually easily available. There are different varieties of rocks available according to the process of formation of rocks or the place of origin in this world. They all have their specific characteristics which segregate them for various purposes to be used in the building construction industry. Rock is a very dense material so it gives a lot of protection too. Its main drawback as a material is its weight and awkwardness. Its energy density is also considered a big drawback, as the stone is hard to keep warm without using large amounts of heating resources. Dry-stone walls have been built for as long as humans have put one stone on top of another. Eventually, different forms of mortar were used to hold the stones together. Cement is the most common building material used to bind rocks together nowadays.

The granite-strewn uplands of Dartmoor National Park, United Kingdom, for example, provided ample resources for early settlers. Circular huts were constructed from loose granite rocks throughout the Neolithic and early Bronze Age, and the remains of an estimated 5,000 can still

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be seen today. Granite continued to be used throughout the Medieval period (see Dartmoor longhouse) and into modern times. Slate is another stone type, commonly used as roofing material in the United Kingdom and other partsof the world where it is found. Mostly stone buildings can be seen in most major cities, some civilizations built entirely with stone such as the Pyramids in Egypt, the Aztec pyramids, and the remains of the Inca civilization.

Stone is a very important and useful building construction material found from mountains and big land structures/masses.

Stones are found in different colors, textures, appearances, and qualities.

The qualities of the stones depend on the type of source mountain from where it is obtained. Some special types of stones like white stones or other colorful stones are very precious and costly while on the other hand sandstones and limestones are much cheaper. In the same way, Granite stones are very strong and hard while serpentine stones are as soft as they can be cut by a knife. Various stones have varying qualities.

- Universal building material for application in all conditions is yet to be found out.
- Classification according to convenience
  - cement materials such as lime, cement, mortar.
  - protective materials as paints, varnishes, plaster, etc.
  - solid materials as stones, bricks, iron, timber, etc.

➢ **Thatch**

Thatch is one of the oldest materials known; the grass is a good insulator and easily harvested. Many African tribes have lived in homes made completely of grasses year-round. In Europe, thatch roofs on homes were once prevalent but the material fell out of favor as industrialization and improved transport increased the availability of other materials. Today, though, the practice is undergoing a revival. In the Netherlands, for instance, many new builds too have thatched roofs with special ridge tiles on top.

➢ **Brush**

Brush structures are built entirely from plant parts and are generally found in tropical and subtropical areas, such as rainforests, where very large leaves can be used in the building. Native Americans often built brush structures for resting and living in, too. These are built mostly with branches, twigs and leaves, and bark, similar to a beaver's lodge. These were variously named wakeups, lean-tos, and so forth.

➢ **Ice**

Ice was used by the Inuit for igloos, but has also been used for ice hotels as a tourist attraction in northern areas that might not otherwise see many winter tourists.

➢ **Wood in timber form**

Wood is a product of trees, and sometimes other fibrous plants, used for construction purposes when cut or pressed into lumber and timber, such as boards, planks, and similar materials. It is a generic building material and is used in building just about any type of structure in most climates. Wood can be very flexible under loads, keeping strength while bending, and is incredibly strong when compressed vertically. There are many different qualities to the different types of wood, even among the same tree species. This means specific species are better for various uses than others. And growing conditions are important for deciding quality as its bad growth leads to various timber defects.

Historically, wood for building large structures was used in its unprocessed form as logs. The trees were just cut to the needed length, sometimes stripped of bark, and then notched or lashed into place. In earlier times, and in some parts of the world, many country homes or communities had a personal wood-lot from which the family or community would grow and harvest trees to build with. These lots would be tended to like a garden. With the invention of mechanizing saws came the mass production of dimensional lumber. This made buildings quicker to put up and more uniform. Thus, the modern western style home was made.

➢ **Brick and Block**

A brick is a block made of kiln-fired material, usually clay or shale, but also may be of lower quality mud, etc. Clay bricks are formed in a moulding (the soft mud method), or in commercial manufacture more frequently by extruding clay through a die and then wire-cutting them to the proper size (the stiff mud process). Bricks were widely used as a construction material in 1700, 1800 and 1900s. This was probably due to the fact that it was much more flame retardant than wood in the ever-crowding cities, and fairly cheap to produce. Another type of block replaced clay bricks in the late 20th century. It was the Cinder block. Made mostly with concrete. An important low-cost material in developing countries is the Sand Crete block, which is weaker but cheaper than fired clay bricks.

➢ **Concrete**

Concrete is a composite building material made from a combination of aggregate (composite) and a binder such as cement. The most common form of concrete is Portland cement concrete,

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which consists of mineral aggregate (generally gravel and sand), Portland cement, and water. After mixing, the cement hydrates and eventually hardens into a stone-like material. When used in the generic sense, this is the material referred to by the term concrete. For a concrete construction of any size, as concrete has a rather low tensile strength, it is generally strengthened using steel rods or bars (known as rebars). This strengthened concrete is then referred to as reinforced concrete. To minimize any air bubbles, that would weaken the structure, a vibrator is used to eliminate any air that has been entrained when the liquid concrete mix is poured around the ironwork. Concrete has been the predominant material in this modern age due to its longevity, formability, and ease of transport.

- **Metal**

Metal is an element, compound, or alloy that is a good conductor of both electricity and heat. Metal crystal structure and specific metal properties are determined by holding together the atoms of metal. They are materials that are typically hard, opaque, shiny, and has good electrical and thermal conductivity.

Metal is used as a structural framework for larger buildings such as skyscrapers, or as an external surface covering. There are many types of metals used for building. Steel is a metal alloy whose major component is iron and is the usual choice for metal structural construction. It is strong, flexible, and if refined well and/or treated lasts a long time.

Corrosion is metal's prime enemy when it comes to longevity. The lower density and better corrosion resistance of aluminum alloys and tin sometimes overcome their greater cost. Brass was more common in the past but is usually restricted to specific uses or specialty items today. Metal figures quite prominently in prefabricated structures such as the Quonset hut, and can be seen used in most cosmopolitan cities. It requires a great deal of human labor to produce metal, especially in the large amounts needed for the building industries. Other metals used include titanium, chrome, gold, silver. Titanium can be used for structural purposes, but it is much more expensive than steel. Chrome, gold, and silver are used as decoration because these materials are expensive and lack structural qualities such as tensile strength or hardness.

- **Glass**

Glass is the only material strong enough to go up to the bottom of the ocean and maintain its buoyancy. Clear windows have been used since the invention of glass to cover small openings in a building. They provided humans with the ability to both let light into rooms while at the same time keeping inclement weather outside. Glass is generally made from mixtures of sand and silicates, and is very brittle. Modern glass "curtain walls" can be used to cover the entire facade of a building. Glass can also be used to span over a wide roof structure in a "space frame".

- **Ceramics**

Ceramics are such things as tiles, fixtures, etc. Ceramics are mostly used as fixtures or coverings in buildings. Ceramic floors, walls, countertops, even ceilings. Many countries use ceramic roofing tiles to cover many buildings. Ceramics used to be just a specialized form of clay-pottery firing in kilns, but it has evolved into more technical areas.

- **Plastic**

The term plastics covers a range of synthetic or semi-synthetic organic condensation or polymerization products that can be molded or extruded into objects or films or fibers. Their name is derived from the fact that in their semi-liquid state they are malleable, or have the property of plasticity. Plastics vary immensely in heat tolerance, hardness, and resiliency. Combined with this adaptability, the general uniformity of composition and lightness of plastics ensures their use in almost all industrial applications today.

- **Foam**

Foamed plastic sheet to be used as backing for firestop mortar at CIBC bank in Toronto. More recently synthetic polystyrene or polyurethane foam has been used on a limited scale. It is lightweight, easily shaped, and an excellent insulator. It is usually used as part of a structural insulated panel where the foam is sandwiched between wood or cement.

- **Cement composites**

Cement bonded composites are an important class of construction material. These products are made of hydrated cement paste that binds wood or alike particles or fibers to make pre-cast building components. Various fibrous materials including paper and fiberglass have been used as binders.

Wood and natural fibers are composed of various soluble organic compounds like carbohydrates, glycosides, and phenolics. These compounds are known to retard cement settings. Therefore, before using wood in making cement-bonded composites, its compatibility with cement is assessed. Wood-cement compatibility is the ratio of a parameter related to the property of a wood-cement composite to that of a neat cement paste. The compatibility is often expressed as a percentage value.

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To determine wood-cement compatibility, methods based on different properties are used, such as hydration characteristics, strength, interfacial bond, and morphology. Various methods are used by researchers such as the measurement of hydration characteristics of a cement-aggregate mix; the comparison of the mechanical properties of cement-aggregate mixes and the visual assessment of microstructural properties of the wood-cement mixes. It has been found that the hydration test by measuring the change in hydration temperature with time is the most convenient method.

➢ **Building Materials in Modern Industry**

Modern building is a multibillion-dollar industry, and the production and harvesting of raw materials for building purposes is on a worldwide scale. Often being a primary governmental and trade key point between nations. Environmental concerns are also becoming a major world topic concerning the availability and sustainability of certain materials, and the extraction of such large quantities needed for the human habitat.

➢ **Virtual Building Materials**

Certain materials like photographs, images, text may be considered virtual. While, they usually exist on a substrate of natural material themselves, they acquire a different quality of salience to natural materials through the process of representation.

➢ **Building Products**

When we talk about building products, we refer to the ready-made particles that are fitted in different architectural hardware and decorative hardware parts of a building. The list of building products exclusively excludes the materials, which are used to construct the building architecture and supporting fixtures like windows, doors, cabinets, etc. Building products do not make any part of a building rather they support and make them working.

❖ Properties of Engineering Materials

✓ There are various properties that help us decide which building construction material is beneficial in which kind of a buildings.
✓ Chemical properties: It is the tendency to combine with other materials or substances.
✓ Electrical properties: It is the ability of material to resist electrical flow of current. It includes conductivity, resistivity, dielectric constant and strength deformation, etc.
✓ Magnetic properties: It is the study of permeability hysteresis and coercive force for generator.
✓ Mechanical properties: It is the elasticity, hardness, plasticity, and strength, etc.
✓ Optical properties: It includes scientific phenomenon like scattering, refraction, reflection, absorption, etc.
✓ Physical properties: It includes the bulk density of the material, durability, porosity, etc.
✓ Thermal properties: These materials are required for fluctuating high heat and high temperatures by specific heat capacity, conductivity, and thermal expansion.
✓ Technological properties: It is the bearings on processing or application.

❖ Physical Properties

✓ Bulk density: mass of a unit volume of material in the natural state including pores and voids. It affects the properties of heat, strength, and conductivity of the materials for example bricks have 16-18kN/cu. m bulk density and steel has 78.5kN/ cu m.
✓ Chemical resistance: the materials should withstand acid, alkali, gas/salt. These kinds of materials are used in sewer pipes, hydraulic engineering installations, sanitary facilities, etc.
✓ Co-efficient of softening: it is the ratio of compressive strength and water. Glass and metals have 1, clay has 0, water resisting materials have 0.8 or more.
✓ Density: It is the ratio of mass and volume of homogeneous materials.
✓ Density index: It is the degree in which its volume is filled with solid matter.
✓ Durability: It is the running duration of the material it is composed ofFire resistance: The material should resist high temperatures without losing its load-bearing capacity. The loss of strength or deformation in shape indicated bad fire resistance property of the material.
✓ Frost resistance: It is the property in which it resists freezing or thawing. It depends on density and degree of saturation with water.
✓ Hygroscopicity: It is the property of the material to absorb water vapor by nature of substance involved, number of pores, water retaining hydrophilic substance readily dissolves in water.
✓ Porosity: It is the degree by which volume of material is occupied by pores.
✓ Refractoriness: It is the property to withstand prolonged high temperatures without melting or losing shape.
✓ Spalling resistance: It is the material's endure cycle of sharp temperature variations. It depends on the coefficient of linear expansion of its constituents.

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- ✓ Specific heat: It is the quantity of heat in kCal. iN = heat by 1 deg, C. steel has 0.046*10^3J/N deg C, Stone has 0.075*10^3J/N deg C to 0.09*10^3 J/N deg. C, wood has 0.239*10^3 J/N deg C to 0.27*10^3 J/N deg C
- ✓ Thermal capacity: It is the property of a material to absorb heat. It depends on porosity, density, moisture, and temperature.
- ✓ Thermal conductivity, thermal resistance: thermal resistivity*thickness
- ✓ Water absorption: It is the percentage weight compared. It depends on volume, size, shape and pores.
- ✓ Water permeability: It is the capacity of material to allow water to pass under pressure. Dense metals, steel, glass are impervious to water or waterproof.
- ✓ Weathering resistance: It is the property of the material to resist alternate wet and dry conditions without affecting the shape and structure of the material. It depends on humidity change.
- ❖ Mechanical Properties
- ✓ Abrasion: It is the wearing away property.
- ✓ Creep: It is the fractures due to consistent load with time.
- ✓ Elasticity: It is the ability to restore the initial form without changing.
- ✓ Elastic deformation: due to pressure difference solid deforms loaded and becomes original when unloaded. In ideal deformation there is no change in Hooke's law strain is directly proportional to force.
- ✓ Plastic deformation: It is the condition when solid retains fully or partly. It depends on strain rate, stress, and temperature rate, used in rolling, forging.
- ✓ Fatigue: repeated or fluctuating stress fail material features like uncertainty in structure and service life, ductility, and strength. Its reasons are corroding, stress concentric point, irregular surface, and temperature (fatigue is inversely proportional to temperature)
- ✓ Hardness: It is the property to resist penetration for vulnerability in floors and roads.
- ✓ Impact strength: It is the quantity of work required to cause failure per unit volume.
- ✓ Plasticity ex: (steel bitumen) brittleness: It is changed in shape without failure ex: rock, ceramic, cast iron, glass
- ✓ Strength: it is the safety to bending or impact resistance
- ✓ Wear: abrasion and impact failure causes wear. It is the percentage loss in weight. It is used for road surfaces railways ballasts etc.

Issues with Building Materials

Everything has its advantage and disadvantage so as building materials. These have also issued with the environment, health, etc. during and after construction. These issues can be generated because of improper handling of material, also during the maintenance, refurbishment, and servicing. Different materials having a different impact on the environment and health as we see the stone which causes lungs problem because when be used during construction it has to be reshaped and, in that process, lots of dust generates which is harmful and also excessing amount of dust can cause lungs cancer as per studies. Concrete which generally uses in this modern era also generates issues. In concrete, chromium ions are present which are create skin problems when comes in contact, and also the additives used create irritations. Clay products create problems during firing theirproducts. In this, crystalline silica which is hazardous in nature burns. In the olden days, there is a use of lead in construction which causes problems like paralysis, anemia, malaise, etc. but it is replaced by copper in construction. Copper also has impacts but not in construction but during its manufacturing.

III. CONCLUSION

Choosing the right materials always helps you in a manner of economy, health, and also in the environment. Never choose materials based on their aestheticism and pleasure looks which can be bad for you and you to have to pay a higher price. The materials are to be chosen by knowing their impacts and their climatic zones also because other zone's material always creates problems. In the market, different materials are available as we know the world is developing and new techniques and also designs were developed which uses materials in very unique ways but these ways have their own cost. To save you and your environment you have to wake and those problems and take action also.

ACKNOWLEDGEMENTS

I would like to thank god for giving me an opportunity and my parents for supporting and believing in my decision. Also helping me keep learning and encouraging me.

I would also like to thank Dr. Chandresh Kumar Rastogi, Dr. Shruti, Ajanta Neelam, Ar. Shritik Srivastava, Vinod Kumar Gautam, Swati Singh, Mehul Hotwani, Satish Singh and My RAD Family for helping me whenever I need. They help me in learning new things and exploring the new world of architecture and methods.

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