RECYCLING FOR PURPOSE: REDUCING WASTE AND IMPROVING SUSTAINABILITY IN BUILDING DESIGN AND CONSTRUCTION

Abstract –

The use of recycled materials in building design and construction has gained momentum due to its positive impact on the environment and the economy. Recycled materials such as metal, glass, plastic, wood, and concrete can be used to create sustainable building structures and features that reduce waste, conserve natural resources, and lower the environmental impact of construction. However, the use of recycled materials faces technical, regulatory, and policy challenges that need to be addressed. The potential market demand for buildings constructed with recycled materials needs to be stimulated, and public perception and attitudes need to be improved to encourage greater adoption of recycled materials in building design and construction. The performance and durability of buildings constructed with recycled materials need to be evaluated and compared to traditional buildings to ensure quality and safety. Overall, the use of recycled materials in building design and construction presents an opportunity for the construction industry to become more sustainable and environmentally friendly with continued research, development, and policy support. When recycling materials, instead of creating new products from virgin materials, there are fewer burdens on the economy. Recycle is an economical way for people of all socio-economic circles to acquire the items they need.

Key words: Sustainability, Energy consumption, Thermal insulation, recycled material.

Introduction –

The use of recycled materials in building design and construction has become increasingly popular in recent years, as more people recognize the benefits of reducing waste and conserving natural resources. Recycled materials such as metal, glass, plastic, wood, and concrete can be used to create building structures and features that are both sustainable and aesthetically pleasing. One of the primary benefits of using recycled materials in building design and construction is the environmental impact. By reusing materials that would otherwise end up in

landfills, the construction industry can help to reduce waste and conserve natural resources. This not only benefits the environment but also reduces the cost of construction materials.

In addition, using recycled materials in building design and construction can create new markets for recycled materials and stimulate innovation in the field. This can lead to the development of new and more sustainable building materials and practices. Overall, the use of recycled materials in building design and construction represents an important opportunity for the construction industry to become more sustainable and environment friendly. With the continued research and development, as well as policy and regulatory support, the use of recycled materials can become a key part of sustainable building practices.

Waste is defined as any material produced as a byproduct of human and industrial activity that has no lasting value. The increasing amounts and types of waste, the scarcity of landfill space, and the lack of natural earth materials highlight the urgency of finding innovative ways to recycle and reuse waste; recycling and subsequent reuse of waste can reduce demand on natural resources, ultimately leading to a more sustainable environment. Sustainable construction has become a major concern in construction practices at the expense of the future of our planet. This is due to the fact that the construction industry is a massive consumer of natural resources and also a huge producer of waste. The high consumption of raw materials in the construction industry is one of the main factors causing environmental damage and pollution to our Mother Earth and depletion of natural and mineral resources. The resources such as coarse aggregates, sands and cements are in a disadvantaged position because these resources are not able to satisfy the high demand in the construction industry.

Benefits of using recycled material –

- Energy efficient –

  Using fully or partially recycled materials in your project will significantly reduce energy consumption. This is because the energy required to process recycled materials is far less than that required to harvest or manufacture new materials.

- Reduces emissions –

  If your project uses less energy, it will naturally emit fewer greenhouse gases. According to the UKGBC, the built environment is responsible for about 40% of the UK's total carbon emissions, and the construction industry is a significant part of that. In fact, it is estimated that 11% of global carbon emissions come from construction. If we are to achieve a carbon neutral environment by 2050, the construction industry will need to make some significant changes. And, to further reduce your footprint, you can significantly reduce transportation emissions by choosing a local recycled building materials supplier.

- Cost-efficient –

  We have already discussed that lower landfill usage necessarily means a lower landfill fee. But did you know that recycled building materials are also typically cheaper to purchase? There's a perception that sustainable practices come with a big price tag. In fact, opting for eco-friendly construction is better for your bottom line!

- High power –

  Recycled aggregates and other materials can be just as durable as their non-recyclable counterparts. That means an environmentally friendly, cost-effective choice doesn't have to come at a loss of quality or integrity.

- Reduce landfill waste –

Every truckload of recycled materials is exactly one truckload of materials not going to a landfill. When landfills fill up with construction waste, they produce hydrogen sulfide, which poses a high health risk to people in the surrounding area. The less construction debris that ends up in a landfill, the less gas is produced by those materials and the less land is needed for a landfill.

- Create new jobs –

Recycling is a process that requires a combination of manual labor and automated manufacturing. People are needed to sort and organize recyclable materials so they end up in the right places to be reused. The more waste you send for recycling, the more people are needed to move those materials through the stages.

Types of recycled materials used –

There are various recycled materials that are widely used in the construction industry. Some of the major materials are discussed below in this paper, the use of these materials have decreased the cost of construction as well as there are environmental benefits of using these recycled materials.

1. Glass –
   Glass aggregate is a relatively new material for construction. In general, glass aggregates are durable, stable, and easy to place and compact. This best practice presents typical geotechnical parameters for aggregates composed of 100% glass and for mixtures of glass and natural aggregates. The geotechnical parameters of glass cullet aggregates depend largely on the percentage of glass, gradation, and degree of compaction, and to a lesser extent on the type or source of glass. Construction experience and laboratory results indicate that, within reasonable limits, moisture content and bulk density have relatively little effect on geotechnical properties. Recycled glass is a mixture of different colored glass particles and often consists of a variety of wastes (mainly paper, plastic, soil, metals, and food waste). The presence of different colored glass particles and different types of waste are the main barriers to the reuse of recycled glass in bottle production. Recycled glass particles are generally angular shaped and contain some flat and elongated particles. It is believed that the waste stream from which the glass particles were made determines the quality of the material, particularly the amount of debris in the mixture. The properties of recycled glass indicate that it is suitable as a filler (backfill) material for structural and non-structural applications. Recycled glass alone or in a mixture with natural or recycled aggregates (such as crushed rock and crushed concrete) can be used in a variety of road construction applications, including subgrade, embankment, and drainage media in roads. Measures such as mixing with

natural aggregates and stabilizing the material with additives such as lime, cement, or fly ash can be investigated to improve the shear strength of recycled glass when used in road substructure.

Fig.1 Glass bottle with debris

Fig.2 Crushing of glass

2. Scrap tires –
   Due to the developing industry and the growing population, large amounts of scrap tires are generated. The larger the quantities become, the more difficult and expensive it becomes to dispose of them safely without endangering human health and the environment. In construction, scrap tires are used as light fill, conventional fill, for retaining walls and bridge abutments, as an insulating layer, and for drainage, among other applications. Highway construction requires large quantities of construction materials, so highway agencies are often involved in efforts to recycle and reuse waste materials. Proper use of waste and by-products in transportation requires experience and knowledge of how to use these materials.

Fig.3. Scrap tire

3. Recycled crushed concrete aggregates –
   Recycled concrete aggregate (RCA) or crushed concrete is made from construction and demolition debris. Common projects that generate RCA include demolition of curbs and building slabs, concrete pavements, and concrete block and reinforced concrete structures. RCA is a material composed of 60 to 75 percent high-quality, well-graded

aggregate bonded by a cured cement paste. RCA may contain 10 to 30 percent subgrade material that is removed along with the concrete pavement or asphalt of the shoulder or composite pavement. The RCC used in this study is a slump-free soil-cement mixture that is generally placed with a paver and compacted with a roller to an appropriate density. The use of RCA as a base course and subgrade is more common in the construction of urban and regional jurisdiction roads, which generally have lower traffic volumes. Approval of these materials is also on a case-by-case basis, with most local agencies requiring documentation of material properties and pollutant content prior to use in new roadways.

One of the material that has its thermal properties increased due to the addition of the recycled material in its composition is CONCRETE

4. CONCRETE –
   Concrete is a construction material widely used in building and infrastructural applications. However, its widespread use has affected the reduction of natural resources. Hence, many approaches have been made by researchers to study the incorporation of waste materials in concrete as a substitution for natural resources besides reducing waste disposal problems. Recently, waste materials also known as by-product aggregate is widely used in concrete production that is blast-furnace slags, fly ash (FA), plastic and many others. It is usually used as lightweight aggregate (LWA, very low densities 0.8÷1.0 g·cm-3) by replacing fine aggregate, coarse aggregate or as addition mixture [8]. When mass concrete is used in external walls, thermal insulation is needed. TC of plain concrete is mainly dependent on the moisture content in the pores and on the volume fraction (VF) of the aggregate, as well as on the water cement ratio and the admixture types. TC of concrete can be reduced through the addition of an airentraining admixture (aerated concrete, AC), or through LWA (lightweight concrete). These LWA can be natural or synthetic or also polymers such as wood-derivatives, expanded polystyrene, rubber, PET, combined or not. Some of these aggregates, as crumb rubber (CR), come from recycling processes. CR also may have a significant effect on concrete mix air entrapment, which also reduces TC of concrete. Researches aim to develop sustainable nonstructural concrete with a high amount of recycled rubber. The physico-mechanical properties of concrete are: strengths, permeability, shrinkage, durability, thermal properties, etc. In various thermal properties of concrete TC, which depends upon the composition, is very important in building insulation to measure the ability of a material to transfer heat. TC of concrete depends on several parameters: density, porosity, temperature, amount or volume percentage of materials, type of materials, degree of hydration, water cement ratio, micro-environment relative humidity and mineralogical characteristics of aggregate. Several works suggest that TC is directly proportional to the material’s density. A comparative analysis allows concluding that the λ-values of concrete mixes with recycled aggregates (RA) increases with increasing

density. Many researchers have investigated TC of concrete utilizing waste materials: RA, FA, rubber, expanded perlite, oil palm shell, palm oil fuel ash, recycled glass, plastic waste, sawmill waste, polyamide obtained a similar conclusion when evaluating TC of concrete mixes with RA (fine and coarse) justifying the results with the porosity increase stemming from rising RA contents in the concrete mixes. The other parameter that affects TC of concrete is porosity. TC of the concrete mixes with RA from construction and demolition waste (CDW) were also evaluated, and it was concluded that the use of RA causes a decrease of TC coefficients of the concrete mixes. This decrease was quite significant (17%÷42%) when all the natural aggregates (NA) were replaced with fine or coarse RA. The analysis of the thermal behaviour showed that the use of RA improves the thermal performance of the concrete mixes. The extent of this change was shown to be quite variable depending on the origin of RA used. In addition, the choice of the size of the RA used does not seem to significantly influence the quality of the concrete mixes regarding their thermal performance. The replacement of NA with RA reduces the λ-values of the concrete mixes, therefore improving their thermal and energetic performance for use in building applications where insulation is important. That improvement is quite significant in concrete mixes in which 100% of the coarse and fine NA are replaced, reaching decreases in λ of 42% and 23%, respectively significantly depending on the constitution of the RA used. The different types of RA have quite varied compositions, with different contents of concrete, ceramics, glass, wood, among other materials

Conclusion –

The reuse of recycled materials in construction is very beneficial due to the suitable technical properties of the materials, the lower cost compared to traditional building materials, and the fact that reusing these materials prevents them from being sent to landfills. The biggest issue is probably the environmental impact associated with the reuse of these materials. Much of the materials that are eligible for reuse come from industrial waste. Much of the materials being considered for reuse come from industrial waste. The reuse of these materials in construction usually involves some environmental concerns.