As global populations increase, there is ever increasing demand for housing. However, current mainstream building methods are unsustainable, producing large amounts of climate changing emissions such as CO₂ both during construction and throughout a building's life. The word “sustainability” is started to become mainstream. Oxford dictionary explains the word sustainable as “Conserving an ecological balance by avoiding depletion of natural resources”. So, to be sustainable we need to use the natural resources at rate of which will provide our needs as well as secure the needs of future generations.

Why building sector and building materials are important from sustainability viewpoint one might ask. Perhaps, the numbers below would convince us to their importance¹:

- "Construction and use of our buildings in the EU influence 42% of our final energy consumption, about 35% of our greenhouse gas emissions, more than 50% of all extracted materials and 30% of our water consumption”
- The sector further gives rise to about 35% of total generated waste.
- The massive resource use is naturally related to important environmental impacts.

In the UK, construction uses vast quantities of fossil fuels, accounting for over half of total carbon emissions that lead to climate change. The built environment is also responsible for significant amounts of air, soil and water pollution, and millions of tones of landfill waste. This is a situation that clearly needs to change.

Sustainable Construction is the adoption of materials and products in buildings and construction that will require less use of natural resources and increase the reusability of such materials and products for the same or similar purpose, thereby reducing waste as well. Sustainable construction adoption of materials and products in buildings and construction that will require less use of natural resources and increase the reusability of such materials. Steel, other metals, glass and prefabricated parts using combinations of these, as well as recyclable substitutes for concrete are examples of sustainable materials and products.

Embodied Energy versus Operational Energy

There are two important source of resource use for a building: construction stage and operation stage. Construction stage involves use of materials such as concrete, steel, brick, insulation materials etc. To produce these materials, lots of energy needed. This energy is called “embodied energy”. Embodied energy is the amount of energy consumed to extract, refine, process, transport and fabricate a material.

Operational energy is used for lighting, heating and running our everyday devices. Roughly speaking, through the overall lifetime of an entire building it is the building operations that will account for approximately 75 percent of energy use and carbon footprint, leaving about 25 percent embodied in the products. However, if you look at the same building in the near term, the energy and corresponding carbon footprint embodied in the building materials is a much higher ratio. This comes from the simple observation that all of the CO₂ emissions embodied in products have already been released prior to the

¹. EU Roadmap to a Resource Efficient Europe, (COM(2011) 571)
building ever being operational, and it can take years for the emissions from operations (i.e., energy use) to catch up. In fact, the typical building can operate on the order of 15 or 20 years before its operations match the amount of embodied carbon in the products that went into it. So, a building constructed in 2010 could find in the year 2030 that its total carbon footprint up to that point in its life is made up of only 55 per cent from operations while a whopping 45 per cent is still attributed to the products. Hence, there is a dramatic need to reduce the carbon footprint not only of the buildings, but the products as well.

Currently, construction sector is focusing on reducing operational energy requirements of buildings through energy efficiency. This is achieved by not only building design but also use of insulation materials. Use of the right materials in terms of insulation properties is very important. There is however also a need to use sustainable materials. That is to say materials with low embodied energy and carbon. As seen from the graph below, concrete seems to be a very good material to have. In reality this is not true. Because the amount of materials used in a construction is different. Therefore one needs to look at their use in a building environment. As shown in the figure below, impact of concrete, plastics and metals becomes prominent.

Insulation is a key component of sustainable building design. A well insulated home reduces energy bills by keeping warm in the winter and cool in the summer, and this in turn cuts down carbon emissions linked to global climate change.

In terms of energy efficiency, investing in high levels of insulation materials for your home is more cost-effective than investing in expensive heating technologies. It is worth taking the time to choose the right materials in the context of whole building design.

Insulation materials work by resisting heat flow, measured by an R-value (the higher the R-value, the greater the insulation). This R-value varies according to material type, density and thickness.

As reduction of operational energy is very much related to the insulation materials used, their sustainability performance becomes important as well. Such performance can be assessed with ISO 14040/44 Life Cycle Assessment standards. A life cycle assessment (LCA) is an analysis of every component or phase of a product's manufacture, use and end of life.

Relationship between embodied and operational energy over building lifetime
By using LCA, we can compare all products like for like based on their functional unit. This comparison is shown below for common insulation materials.
With the inevitability of declining fossil fuels, and the threat of global climate change, reducing our energy consumption is an essential survival strategy. Choosing to build green saves energy. The low embodied energy of green products ensures that very little energy went into their manufacture and production, with a direct reduction in carbon emissions. Eco friendly design methodology can further reduce energy consumption by minimising energy inputs for heating, cooling and light, and incorporating energy efficient appliances. Saving energy for the occupant also saves money - an issue that will become increasingly important as the cost of fossil fuels inevitably rises in the near future.