Geopolymer concrete (GPC) represents a significant advancement in sustainable construction materials, offering a viable alternative to Ordinary Portland Cement (OPC) by utilizing aluminosilicate-rich industrial byproducts such as fly ash and slag. Despite challenges related to mix sensitivity and standardization, the evidence suggests that geopolymer concrete is a technically robust and environmentally superior material with strong potential for widespread engineering applications. Through alkali activation--typically employing sodium hydroxide and sodium silicate--these precursors undergo geopolymerization, forming a three-dimensional inorganic polymer network with high mechanical strength and exceptional durability. Findings from prior experimental investigations indicate that GPC exhibits superior resistance to sulfate and acid attack, reduced drying shrinkage and creep, high early-age compressive strength, and enhanced thermal stability compared to OPC. Emphasis is placed on the influence of key variables, including activator concentration, Na_2SiO_3/NaOH ratio, water-to-binder ratio, curing temperature, and reaction time, all of which critically affect the geopolymerization process and resulting mechanical properties. The material's low permeability and chemically stable matrix also render it effective in specialized applications such as marine infrastructure, heavy-duty pavements, precast components, and toxic metal immobilization. Recent global case studies, including large-scale precast elements, industrial flooring, and 3D-printed structures, demonstrate its evolving practical adoption. Overall, GPC is shown to deliver substantial environmental benefits, including up to 80% reduction in CO_2 emissions, while meeting the structural and durability demands of modern construction. This study presents a comprehensive review of the fundamental chemistry, constituent materials, mix design parameters, and performance characteristics of GPC.