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**With steel, cement, and mortar**

Steel is strong and ductile, but unfortunately, the global steel market is not. The annual global production of 1.5 billion tons far exceeds the present needs, and there are no major demands on the horizon that can consume so many millions in excess. The price of iron ore, a major component in steelmaking, has skyrocketed, making up over 20% of the cost of steel, prompting an observer to complain that the steel business has merely become “conversion” with wafer-thin margins of profitability. There are also other concerns. Iron and steel production consumes a large amount of energy and emits 2.7 billion tons of CO₂ annually. In a developing country like India, iron and steel production alone consumes over 7% of total energy generation, and when added to the energy used in the manufacture of cement, accounts for over 10% of total energy generation.

Iron and steel production is generally an efficient process. The efficiency has grown over decades, and in a few manufacturing stages has reached 90% of the theoretical value. How do we then improve the energy efficiency further and decrease CO₂ production? Among the many innovative options suggested by the European conglomerate structured for this mission, Ultra Low-Carbon Dioxide Steelmaking (ULCOS), two processes, electrolysis and hydrogen substitution in the HISarna process, do not directly use carbothermic reduction. Only with such innovations can steelmaking become economical and more energy efficient. Unlike the developed world, developing countries need millions of tons of steel to meet infrastructural needs, and this must be made available with technologies that use a minimum amount of carbon in steelmaking and minimum energy. We can cite a similar story for cement manufacture, where the emerging options are in choosing industrial wastes as raw materials for manufacturing clinkers—the binding element in cement.

Steel and cement have become engineering workhorses for the industrial world. They may lack the glamour one perceives in novel materials, but they provide the wherewithal for building a prosperous and equitable industrial world.

V.S. Arunachalam

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