Steel 'Intensity' and economic growth

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STEEL has enabled our modern way of life. It is the material which engendered urbanization and industrialization and enabled human societies to move out of a predominantly agrarian way of life to the modern city dwelling life style. It has helped lift societies out of poverty, spurring economic growth, and continues to do so around the world today.

Iron, steel's precursor, fueled the industrial revolution starting in 1750, enabling manufacturing equipment in factories and rail transport. Modern steelmaking was developed 150 years ago with the invention of the Bessemer process, in Germany, which allowed the affordable mass-production of steel (an iron alloy). This set off a second industrial revolution, and sustained economic growth.

Machineries made of steel enabled mass production of goods and replaced the artisan and guild system of manual manufacture. The massive use of steel in ocean going vessels and railways created the modern commercial world as goods manufactured in one part of the world could be safely and cheaply transported to be sold in another part of the world.

Steel is one of the most common materials in the world. We rely on it for our housing, transport, food and water supply, energy production, tools and healthcare. Nearly everything around us is either made of steel or manufactured by equipment made of steel.

The steel industry employs more than 2 million people directly around the world, with a further 2 million contractors and 4 million in supporting industries. Considering steel's position as the key raw material supplier to industries such as automotive, construction, transport, power and machine goods, the steel industry is the source of employment for many more hundreds of millions of people.

Country	Steel Stocks (ton/person)	Country	Steel Stocks (ton/person)
Argentina	4.1	Ethiopia	0.1
Australia	9.8	France	7.5
Bangladesh	0.1	Germany	9.0
Brazil	3.1	India	0.4
Canada	12.1	Indonesia	0.3
China	2.2	Japan	13.6
Congo, DRC	0.1	Mexico	4.8
Egypt	1.1	Nigeria	0.1

Fig.1 Source: World Steel Association

Steel is inextricably linked with economic growth and prosperity, as shown in Figure 1. This figure estimates stocks of steel per person, of different nations of the world. As a nation's per capita GDP increases they build up their stock of steel as well.

The table in Fig.1 has to be understood in the context that all of us are indirect 'consumers' of steel. Steel is the invisible skeleton holding us safely together in our high rise concrete houses. A well built concrete apartment of 1500 sft in Gulshan or Dhanmandi has around 7 tons of steel reinforcement which the owner or renter 'consumes' indirectly. His children in school too 'consume' steel indirectly as he does in his office. Similarly a person riding a vehicle 'consumes' steel. The steel in a nation's infrastructure, its ports, airports and bridges and other public utilities is consumed collectively by all its citizens.

According to Fig.1 Bangladesh has a long way to go to attain steel intensity as the vast majority of its population still resides in rural habitations and infrastructure still does not cover the majority of the population. By contrast advanced economies, such as Australia and Canada have much larger steel stock per person, 9.8 and 12.2 tons per person respectively, as its housing, urban centers, and infrastructure is very highly developed.

The pie chart Fig.2 shows the breakup of the steel asset of India and China the two emerging global economic powerhouses. This is typical of steel use in most nations in Asia and other developing nations. Construction which includes Housing and Infrastructure obviously has the largest share.

The chart reveals the ubiquitous nature of steel in the modern world. Steel is present in most modern day articles of use but the steel content is hidden. For example a country is a big user of consumer durable goods such as automobiles and refrigerators and washing machines all of which has very high steel content, but not readily apparent.

In Bangladesh most construction steel can be traced to local production, which is roughly 4 million tons per annum of long products, most of it in reinforcing steel, commonly known as M.S. Rods. Another 0.7 million tons of corrugated galvanized roofing sheets commonly known as C.I. sheets are also produced locally. Steel stock from capital goods such as machineries and transportation vehicles are entirely imported.

The total steel stock of the nation is abysmally low at 0.1 ton per person. To attain the steel intensity of India at 0.4 ton per person our apparent steel use and production must increase by a factor of 4 times This shows our country needs much more investments in infrastructure and utility facilities, which would mean more expressways, bridges, power plants, mass railway networks, ports and airports etc. in the public sector. Investments in the housing sector by the private sector will drive demand for construction steel. Construction steel will dominate Bangladesh steel production for many more years in the future.

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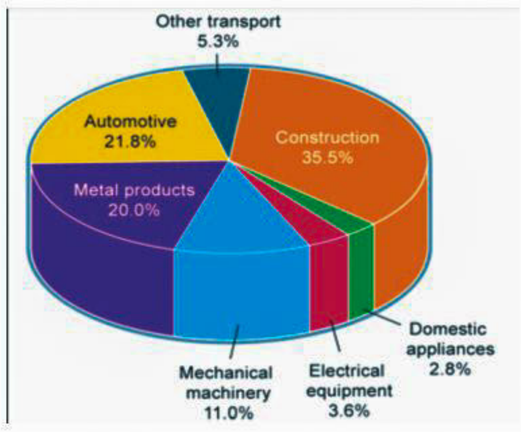

Fig. 2 Steel stock Source: World Steel Association

Ensuring quality in every step of construction & proper maintenance after construction

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BEFORE starting on the subject matter, I would like to quote a relevant incident. At the Time of 2nd World War, a long Bridge suddenly started to crack-down when a large number of Soldiers were passing over the Bridge. The reason of this cracking-down is "the Combined Rhythmic Steps of the Soldiers" as they marched along which matched with the Bridge's Natural Frequency, thereby causing resonance. The possibility of this type of situation was not considered at the time of designing the Bridge.

Though we are discussing about ensuring the quality of construction, I quoted this example to throw light on the fact that the proper design of the structure is very much important for quality construction. So, it is the responsibility of construction engineer to ensure that the design of the said construction is proper and perfect. Moreover, before starting the foundation works, the construction engineer needs to ensure proper filing and to check upon the existing utility Lines.

The quality of construction materials like Re-bars, Cement, Stone/ Brick Chips, Sand etc. is very much important for a quality construction. Therefore, it is an important responsibility of the construction engineer to ensure the quality of the construction materials. For each construction material, there are some standard parameters for measuring quality, such as (i) Re-bars: Tensile Strength, Yield Strength, Cross-sectional Area (ii) Cement: Fineness, Soundness, Consistency and initial & final setting time (iii) Stone/ Brick Chips: Abrasion Test, Sieve Analysis, Water Absorption etc. (iv) Concrete: Compressive Strength etc. So, before starting the Construction, Testing should be done from the standard laboratory at BUET or BSTI.

To maintain the proper ratio of the casting materials is very much important for a quality construction. The ratio of cement, sands and stone chips for high-rise construction or heavy duty construction like Bridge should be 1:1.5:3.

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Cement: The basic building material

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CEMENT is the one of the most important constituents of concrete. The function of cement in concrete is to work as a binding material. Throughout history, such binding properties of cement had played a vital role in the process of civilization. Before invention of this material, crushed masonry aggregate was mixed with calcium oxide as binder. They were used widely in the ancient world. Then the Egyptians used calcined gypsum as cement. The Greeks and Romans used lime made by heating limestone and then mixed it with sand to make mortar. They also used coarser stones to make concrete. Such cement is nonhydraulic and not resistant to water. Later, the Romans found that cement with the ability to set under water could be made, which was then used for the construction of harbours. Such cement was made by adding crushed volcanic ash to lime and was later called "pozzolanic" cement, named after the village of Pozzuoli near Vesuvius. In places where volcanic ash was scarce, such as Britain, crushed brick or tile was used instead. The Romans were therefore probably the first to manipulate systematically the properties of cementitious materials for specific applications and situations.

Today most of the structural concrete is produced by Portland cement and its various modifications. The history of Portland cement began in 1756 and such name was first patented in 1824. In Bangladesh, relative rapid growth of cement industry has been observed in mid 80s. At present, the cement industry of the country is the 40th largest market in the world. Primarily five types of Portland cement are used worldwide. However, in Bangladesh two types of cement are produced known as CEM I and CEM II. CEM I is Ordinary Portland cement (OPC) with no SCM (Supplementary Siliceous Materials such as fly ash, slag, silica fume etc.). CEM II is the Portland Composite Cement (PCC) where SCM or pozzolana is added by replacing the clinker. In areas of durability problem such as sulphate or chloride attack, PCC performs better. Before 2003, mainly OPC was used in Bangladesh. From 2003, production of Portland Composite Cement (PCC) has started in the country following the European Standard Methods (ESM). PCC gives comparable strength and durability like OPC. The basic difference between them is in the manufacturing technology. Only 65% to 80% of clinker is required to produce PCC while 95% of clinker is required to produce OPC. As a result, PCC is gaining popularity worldwide due to its environmental significance.

Clinker plays the most vital role for ensuring the strength and quality of cement. The quality of clinker must be good to get better quality cement. The four basic raw materials necessary for clinker manufacturing are calcium, silica, alumina and iron. Raw material clinker (produced by heating raw mixture of calcium, silica, alumina and iron at high temperatures) is grounded to powder and then mixed with water (Optional) and blended. Then they are burnt, and after burning gypsum is added as retarder. Addition of gypsum controls the "setting of cement". Setting time is essential for keeping cement in plastic phase to make it workable. If gypsum is not added, the cement will set immediately after mixing with water, leaving no time for concrete placement. In addition to compound composition, the fineness of cement also affects its reactivity with water. Limits on fineness of cement are set by cost of grinding and heat evolved on hydration.

Most of the clinker used for cement production in Bangladesh is imported. Only two manufacturers produce clinker at their own plant. One is Chhatak Cement Factory Ltd a government owned company with a limited production capacity. Another one is Lafarge Surma Cement Ltd, which is situated at Chhatak, Sunamganj and produces approximate 10% of total clinker required for Bangladesh.

Clinker, the major ingredient of cement reacts in presence of water within concrete and forms calcium silicate hydrate (C-S-H gel), which actually acts as binder of aggregates in concrete. The reaction with water is called hydration process.

Hydration is the primary reason for strength gaining. Rate of hydration is high in first 7 days of concrete production and consequently strength rapidly increases in early stages. Hydraulic cements (such as Portland cement) are made of a mixture of silicates and oxides, which comes from clinker. It has four main components, which are Belite ($2CaO \cdot SiO_2$ or C2S); Alite ($3CaO \cdot SiO_2$ or C3S); Celite ($3CaO \cdot Al_2O_3$ or C3A) and Brownmillerite ($4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ or C4AF). Both C3S and C2S provide strength to concrete by producing C-S-H gel. However, C2S hydrates at relatively lower rates than C3S. C3A is responsible for stiffening, setting and early strength development. The amounts of these elements are adjusted during cement production to attain desired properties.

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Lafarge Surma Cement factory at Chattak, Sylhet