Bangladesh Standard – An Alternative to Clay Brick

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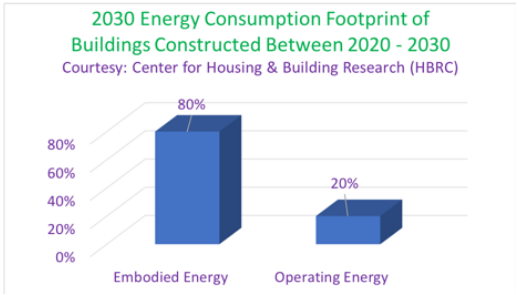
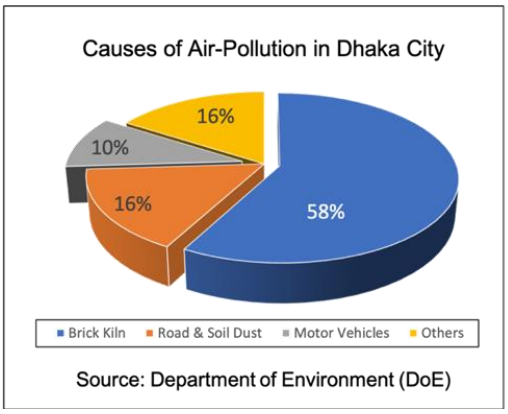
Introduction:

Bricks are rectangular blocks of baked topsoil from agricultural land and are used mainly for building walls and roads. They are also used for making coarse aggregate for concrete in civil engineering structures of some countries including Bangladesh.

Making burnt clay bricks requires a huge amount of topsoil as well as fuel for burning the soil. Studies reveal that every year Bangladesh loses one percent of agricultural land of which 17.4 percent is used for manufacturing bricks amounting to 18,000 hectares (180 square kilometers) of agricultural land. The loss of such vast amounts of land has an explicit negative effect on food security. Moreover, about 8 million tons of coal and wood as a source of 'Embodied Energy' are being used for baking 25 billion bricks per year causing emissions of about 25 million tons of oxides of carbon and usage of 60 million tons of topsoil as raw material. Emissions arising from making bricks account for more or less 15 percent of total national emission. Studies reveal that emissions in Dhaka during the dry season make up as high as 58 percent of total emissions coming out of 1,200 brick kilns in and around Dhaka city. Emission of such huge amounts of carbon is one of the major causes of environmental pollution and use of fuel leads to deforestation which again has an adverse impact on the environment.



As a construction material, bricks are not a good engineering product. Soils from different sources and burning processes cause heterogeneity in the product quality. Bricks make construction immensely time-consuming and laborious. It is not suitable for earthquake resilient building structures. Furthermore, the foundation becomes expensive because of its heavy weight which increases the seismic load and building weight. Since bricks absorb water easily, it causes efflorescence when exposed to a humid environment. Because of the uneven surface and shape of bricks, thick mortar and plaster are required between two bricks and surface of walls, respectively. Because of high water absorption and shrinkage cracks, bricks require more maintenance. Also, it isn't suitable for production on site, when necessary. Use of red clay bricks in the construction industry is therefore morally, environmentally and socially harmful.



To ensure food security, prevent deforestation, reduce environmental pollution, reduce earthquake and structure load, and to get rid of efflorescence, and reduce construction cost, we don't have a choice other than adopting an alternative to bricks. During the last five years, substantial development is visible in the policy framework of the government for adopting concrete blocks as an alternative to clay bricks both for Building and road construction.

Government of Bangladesh committed to replace clay brick by concrete block in all government works by June 2025. Accordingly, leading government organizations like Public Works Department (PWD) and Local

Government Engineering Department (LGED) revised their 'Schedule of Rates' and 'Analysis of Rates' incorporating concrete blocks and other alternative materials and technologies such as Autoclaved Aerated Concrete (AAC) block, Ferrocement/ferrocrete technology etc.

Therefore, it is important to have our own standards and specifications for alternative materials now a days started using in the construction industry. Moreover, the benefits and code of practice for alternative materials and technologies should include in the practice as well as education curriculum.

Advantages of Alternative Building Materials and Technologies:

Alternative building materials and technologies have the following advantages over conventional burnt clay bricks:

1. Conserve Agricultural Land, Forest and Environment;
2. Durable, Cost-effective and Easy Construction;
3. Minimum Waste, Better Finish and Less Maintenance Cost;
4. Better Sound and Heat Insulation Property;
5. Consume Less Energy, Shows Minimum Defects and better Functional Efficiency;
6. Lighter in Weight, Less Earthquake induced Load and Less Structural Cost.

Appropriate Alternative to Brick:
To achieve Sustainable Development Goals (SDG), we can no more use brick as one of the major building materials like sand and stone. Therefore, we need to explore and innovate alternative building materials to substitute bricks. Moreover, the innovative materials and technologies must be environment-friendly, durable, hygienic and affordable i.e. cost-effective. Concrete Block, AAC and Ferrocrete are some of the examples of such materials and technologies. The beauty of these materials and technology is that these ensures the use of indigenous ingredients. One of such ingredients is the sand which is abandoned in north and eastern part of Bangladesh and sometimes it creates problem for navigation. Also, sand sediment in the river-bed make river basin shallower that instigate flood both frequency and severity. Major ingredient of AAC block is sand or fly-ash which is more or less 70% of total ingredients. Bangladesh can best utilize its river-bed sand instead of imported fly-ash. On the other hand, like reinforced concrete, ferrocrete does not requires any imported stone chips as coarse aggregate but requires sand as fine aggregate which will reduce the dependency on import.

Bangladesh Standards:
Though Ferrocement or Ferrocrete technology has its standard and legal endorsement in Bangladesh National Building Code (BNBC) since 1993 but Bangladesh has no National Standards for Concrete Hollow Block and Autoclaved Aerated Concrete Block. On the other hand, as a right step, government is forcing construction sector to use alternative to brick as building block. This made a haphazard situation in the block market as well as construction industry. Over 200 mediums to large size and huge number of small size block manufacturing factories are there in Bangladesh but due to lack of national standard, block shape, size, weight and other engineering properties are different from different manufacturers. At least one large size AAC block manufacturing factory is there in Bangladesh and some more are coming in the market. Without having our national standard, how the professionals and end users will fix the standard and specification of such block. Professionals and consumers have no guidelines even to fix the specification. Both manufacturers and consumers are eagerly waiting and asking us for national standard. Construction sector will suffer seriously if we fail to develop the Standard and gazette the same soon.

Other Country Standards:
HBRC is being working on Standards and Specifications of building materials and technologies for Bangladesh in its limited capacity since 2019. By this time, it reviewed some of the other country standards and practices so as to check for adaptability and/or customize for our country. Gist of some other country standards are presented below:

Concrete Masonry Units:

Indian Standard - Hollow Concrete Blocks shall conform to the following three grades:
Grade A — These are used as load bearing units and shall have a minimum block density of 1500 kg/m^3. These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5, 7.0, 8.5, 10.0, 12.5 and 15.0 N/mm^2 respectively at 28 days.

Grade B — These are also used as load bearing units and shall have a block density between 1100 kg/m^3 and 1500 kg/m^3. These shall be manufactured for minimum average compressive strengths of 3.5 and 5.0 N/mm^2 respectively at 28 days.

The nominal dimensions of concrete block shall be as follows: Length: 400, 500 or 600 mm, Height: 200 or 100 mm, Width: 50, 75, 100, 150,200, 250 or 300 mm.

Table 1: Minimum Face Shell and Web Thickness (All dimensions are in millimetres)

Sl No.	Nominal Block Width	Minimum Face Shell Thickness	Minimum Web Thickness	Minimum Total Web Thickness per course in any 200mm length of Wall
1	100 or less	25	25	25
2	100 – 150	25	25	30
3	150 – 200	30	25	30
4	Over 200	35	30	38

ASTM Standard – Physical and engineering properties are listed below in table 2 & 3.

Table 2: Minimum Face Shells and Web Requirements of Hollow Units:

Nominal Width (W) of Units (inch)	Face Shell Thickness (t_{fs}), min, (inch)	Webs	
		Web Thickness (t_w), min, (inch)	Normalized Web Area (A_{nw}),min, (in^2/ft^2)
3	0.75	0.75	6.5
6	1	0.75	6.5
8	1.25	0.75	6.5

Table 3: Strength, Absorption, and Density Classification Requirements

Density Classification	Oven-Dry Density, lb/ft^3	Maximum Water Absorption, lb/ft^3		Minimum Compressive Strength, lb/in^2	
	Average of 3 Units	Av. of 3 Units	Individual Units	Av. of 3 Units	Individual Units
Lightweight	Less than 105	18	20	2000	1800
Medium Weight	105 to less than 125	15	17	2000	1800
Normal Weight	125 or more	13	15	2000	1800

Table 4: AAC Block Standard Specifications from ASTM, BIS and GB/T (Chinese):

Properties	ASTM	BIS	GB/T (Chinese)
Compressive Strength	> 3.5 MPa	> 3 MPa	> 2.5 MPa
Density	480-800 kg/m3	550-650 kg/m3	400-700 kg/m3
Moisture Content	< 10%	< 10%	< 10%
Thermal Conductivity	< 0.20 W/m.K	< 0.24 W/m.K	< 0.16 W/m.K
Water Absorption	< 10%	< 10%	< 10%
Fire Resistance	> 2 Hours	> 4 Hours	> 4 Hours

Bangladesh Public Works Department (PWD) Standard:
In absence of BSTI standard, PWD assumed its own standard specification of concrete blocks (Table-4) for its use which seems more conservative compare to other country standards.

Table 5: Bangladesh PWD Standard Specifications

Dimensions	Block Shell, min.	Max. Water Absorption	Compressive Strength, min.	Application Areas
(390 x 190 x 240)	32 mm	7%	15 MPa	240 exterior walls
(390 x 190 x 112)	25 mm	7%	15 MPa	112 thick partition walls
(240 x 114 x 70-3H)	32 mm	7%	15 MPa	240 mm thick exterior walls
(240 x 114 x 70-3H)	25 mm	7%	15 MPa	114 mm thick partition wall
(390 x 190 x 112)	25 mm	7%	10 MPa	112 mm thick boundary wall

HBRC Findings:

HBRC conducted several studies on different building materials. Findings and comparative statements on Cost and Engineering Properties of those building materials and technologies are below in table 5 & 6.

Table 6: Social Cost Analysis of a Concrete Block (390x190x100) and equivalent Bricks (4.5 Nos.):

Location	Product	Apparent Price	Environmental Price	Total (Social Cost Price)	Remarks
Dinajpur	Block	45	5	50	(-) 38%
	Brick	60	20	80	(+) 60%
Gazipur	Block	50	5	55	(-) 31%
	Brick	60	20	80	(+) 45%
Khulna	Block	53	5	58	(-) 36%
	Brick	70	20	90	(+) 55%
Noakhali	Block	55	5	60	(-) 29%
	Brick	65	20	85	(+) 42%

Table 7: Comparative Statement of Engineering Properties (Infill Wall Materials):

Properties	Clay Brick (125)	Concrete Hollow Block (100)	AAC Block (100)	Ferrocrete (30)	Sandwich Panel (125)
Weight per sft in kg	20	12	6	6	10
Cost per sft in BDT	120.00	80.00	90.00	80.00	110.00
Energy Consumption/sft	60 MJ	8 MJ	21 MJ	8 MJ	10 MJ
GHG emission/sft	6 kg	1 kg	2 kg	2 kg	2.5 kg
Disaster Resilient	Poor	Very Good	Excellent	Excellent	Excellent
Speed of Construction	Slow	Good	Excellent	Excellent	Good
Durability	Good	Good	Good	Excellent	Very Good
Internal Comfort	Good	Very Good	Excellent	Poor*	Excellent
Maintenance	Poor	Good	Very Good	Excellent	Good
Fire Rating	Good	Good	Excellent	Excellent	Excellent
Versatility	Very Good	Good	Good	Excellent	Good
Efflorescence	Poor	Very Good	Excellent	Excellent	Excellent
Insulation	Good	Very Good	Very Good	Good	Excellent

*Grading poor is for single leaf but for double leaf internal comfort is Excellent. Single leaf is good for internal wall.

Conclusion:

To achieve sustainable Development Goals, construction industry needs to adopt building materials and technologies that is sustainable, environment friendly and cost effective. Clay burn brick has direct negative impact on sustainability, environment and cost. Therefore, it is high time to replace brick as construction material and adopt alternative materials and technologies like Concrete Block, AAC Block, Sandwich Panel and Ferrocrete Technology. National Standards regarding these materials and technologies has to be developed and enacted without delay. BSTI can take initiative to work together with research organizations in this regard.