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ESTIMATION OF CO_2 EMISSION FROM WIDELY USED BUILDING MATERIALS AND GREEN CONCRETE ALONG WITH THEIR COMPARISON

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ABSTRACT

Bangladesh is a developing country. The construction sector is growing rapidly in Bangladesh which ultimately emits a great amount of greenhouse gases. As the process of manufacturing, transporting of buildings materials and installing, constructing of buildings consume greatenergy and emit large quantity of greenhouse gas specially CO_2, so the construction of buildings has a very important impact on the environment. This paper covers the aspect onhow to choose a material for green concrete. It presents the feasibility of the usage of byproductmaterials like fly ash, ground granulated blast furnace slag, recycled concrete or manufacturing aggregates inconcrete and geopolymer concrete. In our study we used different empirical equations for the determination of CO_2 emissions from widely used building materials. Then that calculatedCO_2emissions was reduced by percentage for various green concrete materials. The difference between the emission of CO_2 from widely used building materials and green concrete is also discussed. Dhaka, the capital of Bangladesh is one of the most polluted city, where the building construction site contributes the CO_2 emission in a greatamount. If this emission of CO_2 cannot be controlled right now, it will become a threat for theinhabitants of this city. So, the use of green concrete is gradually becoming anindispensable ingredient for the building materials in this mega city.

KEYWORDS: Green Concrete (Fly Ash, ground granulated blast furnace slag, Geopolymer), Greenhouse gas (CO_2).

1. INTRODUCTION

The size of construction industry all over the world is growing at faster rate. The huge construction growth boosts demand for construction materials. On the other hand, aggregates are the main constituent of concrete. Due to continuously mining the availability of aggregates has emerged as a problem in recent times. To overcome this problem, there is need to find replacement to some extent becauseit has been studied that only fromcement profile, 0.9 tons of CO_2 is produced per ton ofcement production.[1] Nowadays, there is a solution to some extent and the solution is known as "Green Concrete". Green concrete has nothing to do with color. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life.[2] It was first invented in the year 1998 by Dr. WG in Denmark.[3] In 1997, the Kyoto Conference took place. In that conference several guidelines were laid down by the participating countries of that conference after discussing the environmental conditions of that time. The guidelines – Kyoto Protocol, as they are called, needed the countries to cut down their CO_2 emissions to a certain degree as assigned. The given goal had to be achieved by the year 2012.[4] From then many countries started to focus on different available options but Denmark targeted on cement and concrete production as Denmark's total CO_2 emission comes from cement and concrete production near 2%.[4] Green construction materials are composed of renewable, rather than non-renewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product. Recycled materials that the Industry has found to perform favorably as substitutes for conventional materials include: fly ash, granulated blast furnace slag, recycled concrete, demolition waste, geopolymer etc.[5] Generation and use of recycled materials varies from place to place and from time to time depending on the location and construction activity as well as type of construction projects at a given site. However green concrete is expected to fulfil some environmental obligations. For example, in accordance with the Kyoto Protocol of 1997, CO_2 emission needs to be reduced by 21 %.[6] Again the use of inorganic residual products from industries other than the concrete industry needs to be increased 20% approximately.[7] In our paper we estimate the emission of CO_2 from different types of widely used building materials like cement, brick, steel etc. and green concrete like fly ash, geopolymer etc. We also determinethe total CO_2 emission from various buildings of different elevations. Then we compare the results of CO_2 emission from widely used building materials and green concrete.

2. METHODOLOGY

In order to carry necessary calculations for our study, plan of buildings are chosen. Three different plans of different storey building namely four storey building, seven storey building and ten storey building have been chosen. The general consideration that will be followed to collect different types of data of bricks, cement, sand, steel, glass etc. are given systematically as types of fuel used for burning (wood, gas, coal) ,amount of the fuel used for burning, working hour for production and electricity used for production andamount of fuel required for transportation and sieving. There might be other factors (paint and water uses etc.) to be considered but we will consider the major factors of carbon emission and energy consumption. All the building materials are considered to be available locally & the analysis is mainly focused on Bangladeshi building materials. A table comprising of different data for various building materials will be prepared in order to carry out the project work smoothly. Focus should be given on the emission data selection criteria. There are six criteria that have been applied for the selection of CO_2 emission values for individual materials[8] namely Compliance with approved methodologies, System boundaries, Origin of data, Age of data sources, Operating CO_2 emission& Carbon dioxide emission factors. The emission factors have been used from unit conversion fact sheet by MIT (2007)[9] and Guidance for Voluntary, Corporate Greenhouse Gas Reporting: Data by New Zealand (Fuel combustion emission factors 2008).

2.1.1 Location of the Buildings

The location of building is important as distance is one of the important parameter for empirical formulas. The distance along with their type of building is given below:

(a) Case I

Storey Number: 4

Number of Floor: 3rd floor with Ground Floor

Type: Officers Dormitory Building

Location: The construction Site is near Aftab Nagar, Dhaka

Area of Building: Length = 17.25 m; Width = 8 m

Per Floor Height: 3.20 m

(b) Case II

Storey Number: 7

Number of Floor: 6th floor with Ground floor

Type: Residential Building

Location: The construction Site is near Banasree, Dhaka

Area of Building: Length = 129 ft; Width = 77 ft

Per Floor Height: 10 ft

(c) Case III

Storey Number: 10

Number of Floor: 9th floor with Ground floor

Type: Residential Building

Location: The construction Site is near Badda, Dhaka

Area of Building: Length = 129 ft; Width = 77 ft

Per Floor Height: 10 ft

2.1.2 Building Materials Location

(a) Brick:

Company Name: Abdul Monem Auto Bricks ltd

Location: Gazaria, Munshijanj

(b) Cement:

Company Name: Shah Cement

Location: Muktarpur, Munshiganj.

(c). Steel:

Company Name: Abulkhair Steel

Location: West Muktarpur, Munshiganj

(d). Sand:

Location: Sunamganj district

(e). Timber:

Location: Sundarban of Bangladesh.

2.2 Calculation Procedure

The calculation procedure can be divided into three phases namely:

2.2.1 Estimation of different widely used building materials

At first the main focus will be given on the estimation of different building materials. The commonly known widely used building materials that will be estimated in our calculation are Cement, Aggregate, Sand, Brick, Steel, Timber & Concrete. The total amount of building materials used during the construction will be determined separately for respective widely used building materials.

2.2.2 Determination of CO_2 emissions from widely used building materials:

In this phase our prime goal is to determine the emission of $CO_2$from different widely used building materials.

The formulae that will be used in determining the emission of CO_2 are given below. These empirical equations were developed by S. Khusru& M. A. Noor for any location of Bangladesh.

(i) Brick Profile

Cradle to grave emission=380.25+0.21(d_{b1} +d_{b2}) (g CO_2 /single brick)[8] …………. (1)

Where

d_{b1} = distance in km from brick field to construction site;

d_{b2} = distance in km from construction site to brick chips processing site.

(ii) Cement Profile

Cradle to Gate Emission

CEM- I = 870 + 50 d_c (kg CO_2/ton)[8] ……………………………………………(2)

(2) Where d_c = total distance in km from cement factory to market and market to construction site.

(iii) Steel Profile

Total life cycle emission (max) =800+ 0.05 (d_{st1} +d_{st2}) +8.1h +1.03L + 0.04A (Kg CO_2 /ton)[8]……………(3)

Where

d_{st2} =distance in km from market to construction site;

A=total area of weld for connection in square meter;

h=hoisting height of the crane in meter for one ton of steel element transfer;
L=derricking length of the crane in meter for one ton of steel element transfer.

(iv) Sand Profile

Cradle to gate emission =0.05 +50 d_{st1} (g CO_2/kg)[8] ………………………………… (4)

Where d_{st1} =total distance in km from sand processing unit to market and from market to construction site.

(v) Aggregate Profile

Life Cycle CO_2 Emission: 65+ 50 (d_a + d_{ad}), (g CO_2/kg)[8]………………………………..(5)
Where, d_a = total distance in km from processing unit to market and from market to construction site;

d_{ad} = distance in km from construction site to disposal site.

(v) Timber Profile
Cradle to grave emission =0.12t/v +3.45 +0.05 (d_{t1}+d_{t2}) (kg CO_2/ cft)[8]…………………. (6)

Where,
t = no of trees cut;
dt_1=distance in km from wood to saw mill;
d_{t2}=distance in km from sawmill to construction site;
V=volume of timber cut in cubic feet.

2.2.3 Minimization of CO_2 emissions by using Green Concrete
In this phase, the focus will be given on the minimization of the emissions of CO_2 by using the alternatives of traditional ingredients of building materials. It would be better to state earlier that all traditional building materials cannot be exchanged or alternated totally due to maintain the code for the construction of buildings. However by reducing some traditional ingredients of building materials and replacing them with the alternatives of traditional ingredients of building materials, the emissions of CO_2 can be minimized efficiently.

The way to minimize the emissions of CO_2 by means of Green Concrete is discussed below:
(i) Ground Granulated Blast Furnace Slag (GGBFS): 55% of GGBS can reduce the embodied the CO_2 content of a typical C12/40 concrete from approximate 115 kg CO_2/ton to approximate 60 kg CO_2 /ton.[10]

(ii) Pulverized Fly Ash (PFA):30% of Fly Ash can reduce the embodied the CO_2 content of a typical C12/40 concrete from approximate 115 kg CO_2 /ton to approximate 85 kg CO_2 /ton.[10]

(iii) Manufacturing of Aggregates:The fine and coarse aggregates are assumed to be locally quarried basalt and river sand. The emission of CO_2 can be minimized by multiplying the determined total amount of emitted CO_2 gas from the buildings with the factors of emissions. The factors of emission is given below:

Table 1: Factor of emissions.[11]

Activity	Emission factor	Unit
Concrete batching	0.0033	kg CO_2.e/m^3
Concrete transport	0.0094	kg CO_2.e/m^3
On site placement activities	0.009	kg CO_2.e/m^3

(iv) Geopolymer: As substitute materials of OPC, 19–29% reductions in CO_2-e are feasible in geopolymer concrete.[11,12]

3. CALCULATION

3.1 Estimation of widely used building materials

Six building materials namely brick, cement, sand, aggregate, steel and timber has been estimated as they contribute in the emission of CO_2 to the environment. Table-2 shows the summation of these six widely used building materials from three storey, seven storey and ten storey building respectively.

Table 2: Quantity of estimated building materials.

Ingredients		Case No	
	I	II	III
Brick (Nos)	42371	694941	1011813
Cement (Bag)	2311	13247	16496
Sand (cft.)	6600.5	33000	42212
Aggregate (cft.)	6518	50847	63266
Steel (kg)	27087.85	174060	219892
Timber (cft.)	9170.63	44070.45	66189.46

3.2 Determination of CO_2 emissions from widely used building materials

3.2.1 Brick Profile

The amount of CO_2 that was emitted during the construction of building is formulated in Table 3.

Equation-1was used to determine the emission of CO_2.

Table 3: Determination of CO_2 from brick profile.

Case No	Distance from brick field to construction site, d_{b1}(Km)	Distance from construction site to brick chips processing site, d_{b2}(Km)	CO_2 Emission (g CO_2 /single brick)	Total number of Bricks used (Nos)	Total emissions of $CO_2$from Brick Profile (g)	Total emissions of $CO_2$from Brick Profile (Kg)
I	43.7	0.250	389.4795	42371	16502635.89	16502.64
II	39.9	0.350	388.7025	694941	270125304	270125.304
III	42.5	0.250	389.2275	1011813	393825444.5	393825.4445

3.2.2 Cement Profile

Equation-2 was used to determine the emission of CO_2 which is represented in Table 4.

Table 4: Determination of CO_2 from cement profile.

Case No	Total distance from cement factory to market and market to construction site, d_c(Km)	CO_2 Emission (kg CO_2/ton)	Total cement used (Bags)	Total cement used (cft)	Total cement used (Ton)	Total emissions of $CO_2$from Cement Profile(Kg)
I	35.2	2630	2311	2888.75	123.19	323989.7
II	29.1	2325	13247	16558.75	706.13	1641752.40
III	34.5	2595	16496	20620	879.32	2281829.42

3.2.3 Steel Profile

Equation-3 was used to determine the emission of CO_2 which is represented in Table 5.

Table 5: Determination of CO_2 from steel profile.

Case No.	Distance from rerolling mills to market, dst1 (Km)	Distance in km from market to construction site, d_{st2} (Km)	Hoisting height of the Crane for one ton of steel element transfer, h (m)	Derricking length of the crane for one ton of steel element transfer, L (m)	CO_2 Emission (kg CO_2/ton)	Total steel used (Ton)	Total emissions of $CO_2$from Steel Profile (Kg)
I	34.6	0.400	6.096	7.62	858.9762	27.08785	23267.82
II	28.5	0.500	6.096	7.62	858.6762	174.060	149461.18
III	34.0	0.500	6.096	7.62	858.9512	219.892	188876.50

3.2.4 Sand Profile

Equation 4 was used to determine the emission of CO_2 which is represented in Table 6.

Table 6: Determination of CO_2 from sand profile.

Case No.	Total distance from sand processing unit to market an from market to construction site, d_{st1} (Km)	CO_2 Emission (g CO_2/kg)	Total sand used (cft.)	Total sand used (kg)	Total emissions of $CO_2$from Sand Profile(Kg)
I	265.6	13280.05	6600.5	285 801.65	3795688.84
II	261.8	13090.05	33000	1428900	1.87×10^7
III	264.4	13200.05	42212	1827779.6	2.41×10^7

3.2.5 Aggregate Profile

Equation 5 was used to determine the emission of CO_2 which is represented in Table 7.

Table 7: Determination of CO_2 from aggregate profile.

Case No.	Total distance from processing unit to market and from market to construction site, d_a (Km)	Distance in km from construction site to disposal site, d_{ad}(Km)	CO_2 Emission (g CO_2/kg)	Total aggregate used (cft)	Total aggregate used (Kg)	Total emissions of $CO_2$from Aggregate Profile(Kg)
I	20.2	3.4	1245	6518	299176.2	37247.37
II	22.2	2.8	1315	50847	2333877.3	3069048.650
III	23.4	3.2	1395	63266	2903909.4	4050953.613

3.2.6 Timber Profile

Equation-6 was used to determine the emission of CO_2 which is represented in Table 8.

Table 8: Determination of CO_2 from timber profile.

Case No.	Distance From wood to saw mill, d_{t1}(Km)	Distance From sawmill to construction site, d_{t2}(Km)	No of trees cut, t	Volume of timber, v (cft)	CO_2 Emission (kg CO_2/ cft)	Total timber used (cft)	Total emissions of $CO_2$from Timber Profile (Kg)
I	282	15	21	9450	18.30	9170.63	167822.53
II	282	21	100	45000	18.60	44070.45	819710.37
III	282	25	150	67500	18.80	66189.46	1244379.50

The total emission of CO_2 is formulated in Table 9.

Table 9: Total emission of CO_2 from widely used building materials.

Building Materials		Case No	
	I	II	III
Brick (Kg)	16502.64	270125.304	393825.4445
Cement (Kg)	323989.7	1641752.40	2281829.42
Steel (Kg)	23267.82	149461.18	188876.50
Sand (Kg)	3795688.84	1.87×10^7	2.41×10^7
Aggregate (Kg)	37247.37	3069048.650	4050953.613
Timber (Kg)	167822.53	819710.37	1244379.50
Total (Kg)	4.36×10^6	2.47×10^7	3.23×10^7

3.3 Minimization of CO_2 emissions by using Green Concrete

It is true that we cannot replace every materials of ordinary building materials like Reinforcement, Sand etc. as they are the indispensable ingredients of building materials. But it is possible to replace a little portion of some building materials like cement, aggregate etc. which will help to minimize the emission of CO_2 in a great extent.

If ordinary Portland cement is replaced by 55%Ground Granulated Blast Furnace Slag (GGBFS), it can reduce the embodied CO_2 content from approximate 115 kg CO_2 /ton to approximate 60 kg CO_2 /ton. 30% of Fly Ash can also reduce the embodied CO_2 content from approximate 115 kg CO_2 /ton to approximate 85 kg CO_2 /ton.[9] On the other hand as a substitute material of OPC, 19%–29% reductions in CO_2 emissions are feasible in geopolymer concrete. However, we will consider the maximum reduction for both GGBFS and PFA and average reduction for geopolymer. In case of manufacturing aggregates, we will multiplied the total amount with the provided emission factor. Table 10 shows the amount of reduction of CO_2 emission due to the use of green concrete.

Table 10: Reduction of CO_2 by using Green Concrete.

Case No.	OPC (Kg)	Reduction of CO_2 emission by cementitious materials (Kg)			Maximum reduction of CO_2 emission by cementitio-us materials (Kg)	Reduction of CO_2 emission by Manufactu-ring of Aggregate (Kg)	Total reduction of CO_2 emission (Kg)
		GGBFS	PFA	Geopolymer			
I	323989.7	7791.76	4250.05	77757.53	77757.53	350.13	78107.65
II	1641752.4	44662.78	24361.48	394020.57	394020.57	28849.05	422869.62
III	2281829.4	55616.99	30336.54	547639.06	547639.06	38078.96	585718.02

In the above table, it is seen that in case of cementitious materials, geopolymer as a substitute material of OPC, reduces the highest amount of CO_2 among all other substitute materials. Hence, geopolymer will be best suitable substitute material of OPC as a cementitious material. Table 11 shows the total emission of CO_2 after the minimization of CO_2 emission by using green concrete.

Table 11: Total emission of CO_2 after using green concrete.

Case No.	CO_2 emission from Widely used building materials (Kg)	Minimized CO_2 emission	CO_2 emission after using Green Concrete (Kg)
I	4.30 x 10^6	78107.658	4.23 x 10^6
II	2.47 x 10^7	422869.626	2.43 x 10^7
III	3.23 x 10^7	585718.021	3.17 x 10^7

4. RESULT AND DISCUSSION

4.1 Comparison of the emission of CO_2 among various building materials

In our study we have mainly focused on the emission of CO_2 from widely used building materials from cradle to grave condition that means during the whole period of construction of a building. It is found that in all cases the emission of CO_2 is greater from sand than other building materials of building like cement, steel, aggregate, timber and brick. It is because in our calculation the formulas that have been used in order to determine the emission of CO_2 are based on the distance of different building materials from production site to construction site as well as different constant coefficient. Tough the distance of timber source found for our calculation is maximum, but CO_2 is emitted quite less from timber while sand emits maximum CO_2. It is because the distance of sand source and timber source is almost equal but the coefficients of sand are higher than timber. Hence, sand plays the vital role in the emission of CO_2 to the environment from the construction sector of building in our calculation. The other building materials can also play the important role of the emission of CO_2 depending on their distances from production sector to construction sector along with their term of higher constant coefficient.

4.2 Comparison of the emission of CO_2 for various cementitious materials

After determining the emission of $CO_2$from widely used building materials we substitute the widely used building materials with the less used building materials and calculate the reduction of emission of $CO_2$by the less used building materials like ground granulated blast furnace slag (GGBFS), pulverized fly ash (PFA), geopolymer etc. Figure 1 shows the emission of CO_2 from different binding materials namely ordinary Portland cement, pulverized fly ash, ground granulated blast furnace slag and geopolymer of three separated storey building namely four storey, seven storey&ten storey building. It is found that when

PFA is used as a substitute of OPC, it reduces a small quantity of CO_2 emission. GGBFS can reduce the CO_2 emission more than PFA. But Geoploymerreduces the greatest amount as substitute materials of cement.

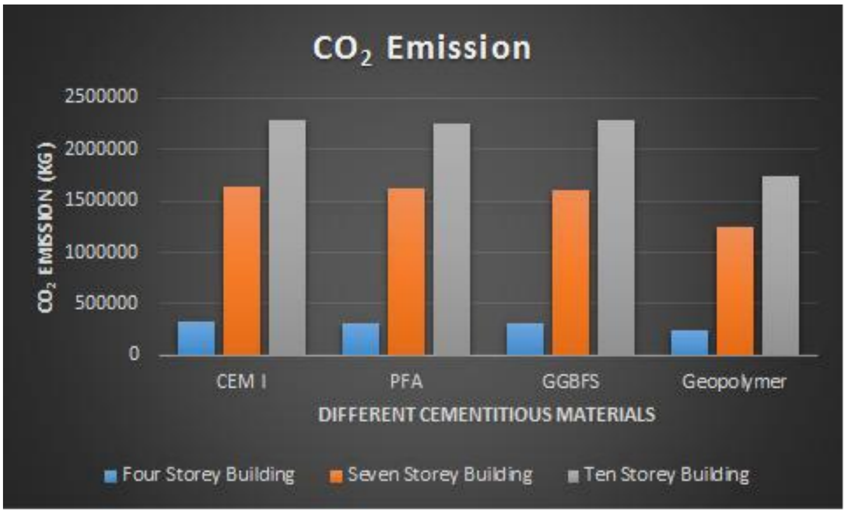

Fig 1: CO_2 emission from different cementitious materials.

4.3 Drawbacks of less used cementitious materials

However, the substitute cementitious materials have the advantage over OPC that they can reduce the CO_2 emission but they have some major drawbacks. The drawbacks are: Sources of substitute materials are not readily available in Bangladesh. So, Current specification doesn't cater to adopt the use of blast furnace slag as a substitute. The Geopolymer concrete (GPC) needs higher temperature curing. Ambient temperature cured GPC has quite lower strength and durability. The properties of GPC are highly depends on the casting curing condition (it is very sensitive to the moisture, temperature, pressure etc.). Also efflorescence is also a big problem for GPC. The quality of fly ash can affect the quality and strength of Cement concrete.Poor quality fly ash can increase the permeability of the concrete and cause damage to the building.

4.4 Comparison of the emission of CO_2between widely used building materials and less used building material (Green Concrete)

Now, if we look onto the overall emission of $CO_2$for both widely used building materials and less used building materials it can be said that green concrete technology reduce the emission of CO_2in a great extent. Figure 2 shows the overall CO_2 emission from different storey building.

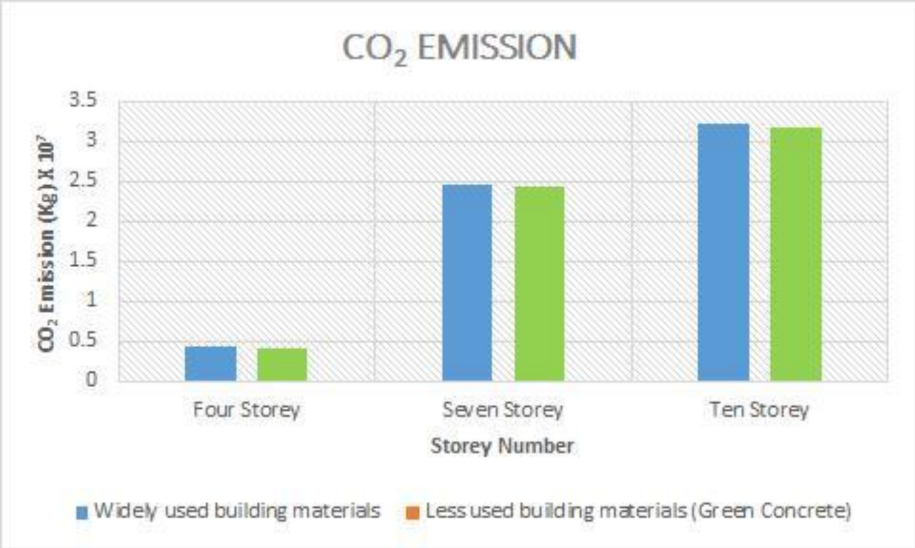

Fig 2: Overall CO_2 emission from different storey building.

From the above figures it is found that the emission of CO_2 from green concrete is quite less than the widely used building materials. So, it is better to start the use of green concrete extensively as a substitute material of widely used building materials in order to prevent environment from the grabs of pollution by building construction sector.

4.5 Graphical representation of the emission of CO_2

Finally figure 3 represents the behavior of the emission of CO_2. That means how they are emitted to the environment. From figure 3, the curve that is obtained is non-linear. It is due to the different locations of buildings that have been selected in our calculation. Because the parameter that controls the emission of CO_2 from building construction depends on the distance of the building ingredients from it's the production zone to building construction zone. So, if the three buildings are placed at the same place, the curve will be linear only then. Except this, the curve will be always non-linear if the locations differ from each other. It is also observed from the behavior of the curve that green concrete minimizes the emissions of CO_2 and as it reduces a fixed amount of percentage from the total emissions of CO_2 from the widely used building materials, so the curve of green concrete will always depend on the behavior of the curve of widely used building materials that means if the curve of widely used building materials is non-linear, the curve of green concrete will also be non-linear and vice-versa.

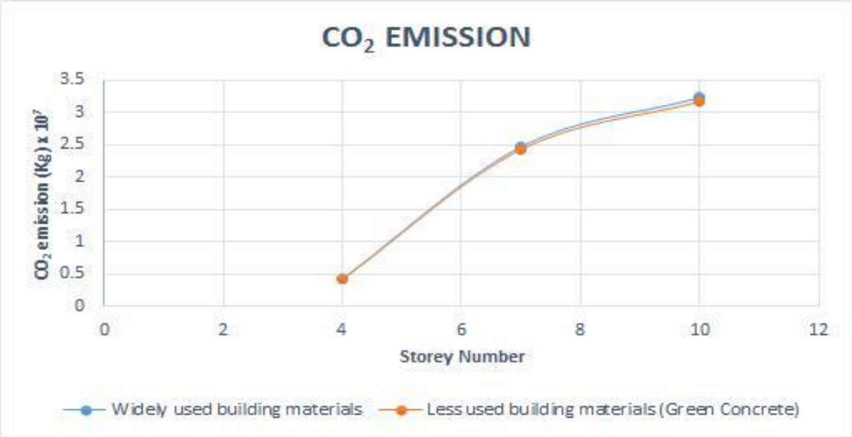

Fig 3: Graphical representation of the emission of CO_2.

Appendix A

Case I

Storey Number: 4

Type: Officers Dormitory Building

Location: The construction Site is near Aftab Nagar, Dhaka

Area of Building: Length = 17.25 m; Width = 8 m

Per Floor Height: 3.20 m

Table A1: Footing Dimension.

Name	Dimension	Name	Dimension
F1	2.70 m X 2.70 m	F4	1.70 m X 3.275 m
F2	2.50 m X 2.50 m	F5	2.20 m X 4.025 m
F3	1.80 m X 1.80m	F6	2.20 m X 3.975 m

Table A2: Grade Beam Dimension.

Name	Dimension
GB1	0.25 m X 0.30 m
GB2	0.25 m X 0.30 m

Table A3: Column (Ground Floor to Roof Floor).

Name	Dimension
C1	0.25 m X 0.25 m
C2	0.25 m X 0.25 m

Table A4: Beam (Ground Floor Beam to Roof Floor Beam & Stair Beam).

Name	Dimension	Name	Dimension
FB1	0.30 m X 0.25 m	FB4	0.30 m X 0.25 m
FB2	0.30 m X 0.25 m	SB	0.30 m X 0.25 m
FB3	0.30 m X 0.25 m	RB	0.30 m X 0.25 m

Slab: (Ground Floor to Roof Floor)

Area = 173.688 m^2

Thickness = 0.115 m

Stair: (Ground Floor)

Initial Landing: Length = 2.68 m; Width = 1.33 m; Height = 0.12 m

Step: Length = 1.34 m; Width = 0.25 m; Height = 0.15 m

Stair: (1^{st} Floor to 3^{rd} Floor)

Landing: Length = 2.68 m; Width = 1.33 m; Height = 0.12 m

Initial Landing: Length = 2.68 m; Width = 1.33 m; Height = 0.12 m

Step: Length = 1.34 m; Width = 0.25 m; Height = 0.15 m

Stair: (Roof Floor)

Landing: Length = 2.68 m; Width = 1.33 m; Height = 0.12 m

Appendix B

Case II

Storey Number: 7

Type: Residential Building

Location: The construction Site is near Banasree, Dhaka

Area of Building: Length = 129 ft; Width = 77 ft

Per Floor Height: 10 ft

Table B1: Footing Dimension.

Name	Dimension	Name	Dimension	Name	Dimension
F2	10’-4” x 10’-5”	F4	8’-4” x 13’-6”	F7B	15’-3” x 14’-7”
F3	9’-7” x 9’	F4A	11’-11’’ x 9’-9’’	FSW44	14’-3’’ x 21’-9’’
F47	9’-2.5’’ x 21’	F14	10’-8’’ x 19’-9’’	F38	25’-9’’ x 24’-4’’
F48	25’-9’’ x 24’-4’’	F65	27’-8.5’’ x 20’-5’’	F16	11’-8’’ x 22’-7’’
F49	26’-11’’ x 24’-6’’	F34	11’-7’’ x 21’-3.5’’		

Table B2: Column (Ground Floor to 6th Floor) Dimension.

Name	Dimension	Name	Dimension
C1 - C2	20"x15" (G.F - 6th)	C3 - C4	25"x12" (G.F - 6th)
C5	30"x12" (G.F - 5th) & 25"x12" (6th)	C5A	25"x15" (G.F - 5th) & 20"x15" (6th)
C6	35"x12" (G.F - 3rd) & 30"x12" (4th - 5th) &25"x12" (6th)	C7A	30"x15" (G.F - 5th) & 25"x15" (6th)
C7B	25"x18" (G.F) & 25"x15" (1st - 6th)	C8	35"x12" (G.F - 5th) & 30"x12" (6th)
C9	35"x12" (G.F - 5th) & 30"x12" (6th)	C9A	35"x15" (G.F - 3rd) & 30"x15" (4th - 6th)

Table B3: Grade Beam Dimension.

Name	Dimension	Name	Dimension
GB1- GB7	12" X 18"	GB9 – GB12	12" X 18"
GB8	10" X 18"	GB13 – GB14	10" X 18"
GB15 - GB18	12" X 18"		

Table B4: Beam (Ground Floor Beam) Dimension.

Name	Dimension	Name	Dimension
B1 – B11	21 in	B17	10 in X 21 in
B12	21 in	B18	12 in X 21 in
B13 – B16	21 in	B19 – B23	10 in X 21 in

Table B5: Beam (1st Floor Beam to 6th Floor Beam).

Name	Dimension	Name	Dimension
B24 – B38	21 in	B48	10 in X 24 in
B39	24 in	B49	10 in X 21 in
B40 – B47	21 in	B50	10 in X 24 in
B51 – B54	21 in		

Slab: (1st Floor to 6th Floor)

Length = 112.17 ft; Width = 47 ft; Thickness = 5.5 in

Stair: (Ground Floor)

Initial Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Step: Length = 5 ft; Width = 10 in; Height = 6 in

Stair: (1st Floor to 6th Floor)

Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Initial Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Step: Length = 5 ft; Width = 10 in; Height = 6 in

Stair: (Roof Floor)

Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Table B6: Shear Wall Dimension.

Name	Dimension
SW_1Below Ground Level	12 in X 87 in
SW_1 Ground Floor to above	10 in X 85 in
SW_3Below Ground Level	19 in X 57 in
SW_3 Ground Floor to above	12 in X 50 in
SW_4Below Ground Level	12 in X 57 in
SW_4 Ground Floor to 6^{th}	10 in X 55 in
SW_4 7^{th} Floor	10 in X 30 in
SW_2Below Ground Level	7 ft 11 in X 12 ft 6 in
SW_2 Ground Floor to above	7 ft 8 in X 12 ft 6 in
APPENDIX C	
Case III	
Storey Number: 10	
Type: Residential Building	
Location: The construction Site is near Badda, Dhaka	
Area of Building: Length = 129 ft; Width = 77 ft	
Per Floor Height: 10 ft	

Table C1: Footing Dimension.

Name	Dimension	Name	Dimension	Name	Dimension
F2	10’-4” x 10’-5”	F4	8’-4” x 13’-6”	F7B	15’-3” x 14’-7”
F3	9’-7” x 9’	F4A	11’-11” x 9’-9’’	FSW44	14’-3’’ x 21’-9’’
F47	9’-2.5’’ x 21’	F14	10’-8’’ x 19’-9’’	F38	25’-9’’ x 24’-4’’
F48	25’-9’’ x 24’-4’’	F65	27’-8.5’’ x 20’-5’’	F16	11’-8’’ x 22’-7’’
F49	26’-11’’ x 24’-6’’	F34	11’-7’’ x 21’-3.5’’		

Table C2: Column (Ground Floor to 9^{th} Floor) Dimension.

Name	Dimension	Name	Dimension
C1 - C2	20”x15” (G.F - 9^{th})	C3 - C4	25”x12” (G.F - 9^{th})
C5	30”x12” (G.F - 5^{th}) & 25”x12” (6^{th} – 9^{th})	C5A	25”x15” (G.F - 5^{th}) & 20”x15” (6^{th} – 9^{th})
C6	35”x12” (G.F - 3^{rd}) & 30”x12” (4^{th} - 5^{th}) &25”x12” (6^{th} – 9^{th})	C7A	30”x15” (G.F - 5^{th}) & 25”x15” (6^{th} – 9^{th})
C7B	25”x18” (G.F) & 25”x15” (1^{st} - 9^{th})	C8	35”x12” (G.F - 5^{th}) & 30”x12” (6^{th} – 9^{th})
C9	35”x12” (G.F - 5^{th}) & 30”x12” (6^{th} – 9^{th})	C9A	35” x 15” (G.F - 3^{rd}) & 30”x15” (4^{th} - 9^{th})

Table C3: Grade Beam Dimension.

Name	Dimension	Name	Dimension
GB1- GB7	12" X 18"	GB9 – GB12	12" X 18"
GB8	10" X 18"	GB13 – GB14	10" X 18"
GB15 - GB18	12" X 18"		

Table C4: Beam (Ground Floor Beam) Dimension.

Name	Dimension	Name	Dimension
B1 – B11	10 in X 21 in	B17	10 in X 21 in
B12	12 in X 21 in	B18	12 in X 21 in
B13 – B16	10 in X 21 in	B19 – B23	10 in X 21 in

Table C5: Beam (1st Floor Beam to 9th Floor Beam) Dimension.

Name	Dimension	Name	Dimension
B24 – B38	10 in X 21 in	B48	10 in X 24 in
B39	10 in X 24 in	B49	10 in X 21 in
B40 – B47	10 in X 21 in	B50	10 in X 24 in
B51 – B54	10 in X 21 in		

Slab: (1st Floor to 9th Floor)

Length = 112.17 ft; Width = 47 ft; Thickness = 5.5 in

Stair: (Ground Floor): Initial Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Step: Length = 5 ft; Width = 10 in; Height = 6 in

Stair: (1st Floor to 9th Floor): Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Initial Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Step: Length = 5 ft; Width = 10 in; Height = 6 in

Stair: (Roof Floor): Landing: Length = 9 ft; Width = 5 ft; Height = 5 in

Shear Wall

Name	Dimension
SW_1Below Ground Level	12 in X 87 in
SW_1 Ground Floor to above	10 in X 85 in
SW_3Below Ground Level	19 in X 57 in
SW_3 Ground Floor to above	12 in X 50 in
SW_4Below Ground Level	12 in X 57 in
SW_4 Ground Floor to 8th	10 in X 55 in
SW_4 9th Floor	10 in X 30 in
SW_2Below Ground Level	7 ft 11 in X 12 ft 6 in
SW_2 Ground Floor to above	7 ft 8 in X 12 ft 6 in

5. CONCLUSION

Global warming is one of the major threats to the environment till date. Production of concrete is one of the vital factors for global warming as it accounts for 30% of the total CO_2 released in the atmosphere.[11] This can be minimized by eco-friendly substitute known as green concrete. In this post we have discussed about all the raw materials for the substitute of conventional concrete to go green. The Green Concrete is a recycled and light weight substances obtained from demolished site and waste of industries. The other one is green cement like fly ash, silica fume and high reactivity met kaolin (HRM). The widely used is fly ash. These green materials have almost same mechanical properties and fire resistant factor as conventional concrete. It has better thermodynamic, environmental and durability properties. It is also cost effective and the construction is faster. Use of concrete product like green concrete in future will not only reduce the emission of CO_2 in environment and environmental impact but it is also economical to produce. It is true that Dhaka is one of the most pollutant city in the world. And the emission of CO_2 play the vital role to pollute this city. Our study shows that building sector is also responsible to emit a large number of CO_2 to the environment. If this emission rate can be reduced in a handsome amount, it will be helpful to save this city, Dhaka from being polluted. However, we try to show a comparison of the emission of CO_2 between the widely used building ingredients and some other alternate building materials of it. It is found that the alternate materials can reduce a little portion of the emission of CO_2 from the total amount. But this reduction amount can be increased if some steps would be taken in course of different time. As the emission of CO_2 is dependent on the distance of the building materials from cradle to grave of a building construction, so if the distance is reduced then the total emission can be automatically reduced. For example, in our study it is proved that sand emits the most emission of CO_2 and it is because the distance of sand is comparatively more than other building materials. So, if this sand can be collected from the nearby of the construction site, the emission will be not as more as our study. So, it becomes inevitable to keep the distance short in order to reduce the total emission of CO_2 from building sector. And if proper substitute materials can be introduced, the emission also can be reduced in a great amount.

REFERENCES

1. https://www.researchgate.net/publication/266912818_GREEN_CONCRETE_EFFICIENT_ECO-FRIENDLY_CONSTRUCTION_MATERIALS.
2. https://www.ijirset.com/upload/2016/october/72_31_EXPERIMENTAL.pdf.

3. https://theconstructor.org/concrete/green-concrete/5566/.
4. Ananth Kamath K & Mohammad Suhail Khan, Green Concrete, Imperial Journal of Interdisciplinary Research (IJIR), 2017; 3(1): Page 685.
5. http://www.yashkrishi.com/GreenConcrete.asp.
6. http://www.kyotoprotocol.com.
7. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.518.5475&rep=rep1&type=pdf.
8. Noor, Amin, Bhuiyan, Chowdhury and Kakoli 4th Annual Paper Meet & 1st Civil Engineering Congress, December 22-24, 2011, Dhaka, Bangladesh (eds).
9. (http://web.mit.edu/mit_energy).
10. https://www.devb.gov.hk/filemanager/en/content_680/6_mr_stephen_leung_carbon_dioxide_emissions_of_concrete.pdf.
11. Collins F. Inclusion of carbonation during the life cycle of built and recycled concrete: influence on their carbon footprint. Int J Life Cycle Assess, 2010; 15(6): 549–56.
12. Flower DJM, Sanjayan JG. Greenhouse gas emissions due to concrete manufacture. Int J LCA, 2007; 12(5): 282.