

## **Choice of prefabricated steel over concrete for industrial construction-A controversy in context of Bangladesh**

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### **Abstract**

*Usually two types of industrial structures exist viz. concrete and pre-fabricated steel structures. Very little studies have been conducted to compare and analyze these structures in the context of Bangladesh. Regardless of a good number of study outside of Bangladesh no rational decisions are available for our country on to which is more beneficial over other . A study comparing different aspects of structures (concrete and pre-fabricated structures) in our country is very important for economic regional point of view.*

### **1. Introduction**

Since the beginning of men's time on earth the idea of houses in the form of caves existed. Later, came houses built with mud, wood etc. and as development through ages progressed so did the need of other structure like storage, production ,etc. arise .In this modern age of technology and science the structures and there construction material vary widely according to purpose, design, uniqueness and advantage .Among the many structures one of the most important structures of modern age are the industrial structures .Usually built with concrete and steel framings. As both materials have substantial advantages it is in fact tough to decide on one. So, people tend to choose between them mostly based on current trend and available capital. Here in the underlying article an attempt has been made to bring out the actual factors that influence the choice of material in a broad outlook.

### **2. OBJECTIVE**

The main objectives of this present study are as follows:

1. To introduce on steel and reinforced concrete in industrial sector.
2. To conduct a questionnaire survey and to make a data table
3. To analyze the data collected and build a comparison table.
4. To analyze approximate cost variation.
5. To make conclusion based on the whole study

### 3. Personal Interviews Based On Formed Questionnaire

Here we conduct this survey to differentiate between Steel and RCC structure and to know the overall condition of those structures in context industrial sector of Bangladesh.

No.	Questionnaire	NAME AND DESIGNATION			
		GENERAL VIEW		ON EXISTING STRUCTURAL VIEW	
		Mohammed Shariful Alam B.sc engg.(civil)mieb Senior designer Multi span building system Ltd.	Engr. Imran Ahmed Senior Manager, project operations. Engr. Umme Suraya Nasrin Structural engineer, project operations. Engr. Pankaj Kumar Halder Manager, project operations. (TRUST ALLIANNCE LTD)	Ali Akbar Khan B.sc Engg.MBA Manager, Engineering Incepta Pharmaceuticals Ltd	Engr. Glolam rabbani parvez B.sc.Engg (KUET). Worked for Reneta Pharmaceuticals Ltd.
01.	What is the type of the Industry?	Answer : All types of industry can be constructed both Steel and R.C.C structure .	Answer: Industries like textile, food, pharmaceutical etc. can be constructed both R.C.C & Steel structure.	Answer: R.C.C structure	Answer: Both R.C.C and Steel Structure.
02.	Cause of selection material?	Answer: Nowadays construction of steel structure is much higher than ever because it is more economical than R.C.C materials & for availability of the materials.	Answer: For overall economical & good resell value of the materials most of the industrialists now chose steel materials structure.	Answer: Before construction of a pharmaceutical industry some consideration should be considered i.e. relative humidity,	Answer: Recently constructed with steel structure because of having light weight, relatively cheaper than RCC

				Temperature .So RCC materials are chosen.	and also for quick constructio n.
03.	What was the duration of construction	Answer: Steel structure can be completed within 6 months where R.C.C structure takes minimum 1 year for completion.	Answer: Steel takes approx: 60% less time required than R.C.C.	Answer: 12 to 18 months for R.C.C structure.	Answer: Construction duration for steel one year till service and for R.C.C 18 to 24 months till service.
04.	What was the approximate construction cost?	Answer: For steel structure approximate construction cost varies (without foundations cost) BDT 600-950 per sq. feet and for R.C.C cost varies (without foundation) BDT 1050-1350 per sq. feet.	Answer: Steel structure saves approximate 30% cost than R.C.C structure.	Answer: Approximate construction cost varies for steel structure BDT 2000-2500 per square feet.	Answer: For steel structure approximately 30% cost reduced.
05.	How many floors in the industry?	Answer: Actually there is no floor limitation for both these type of structure.	Answer: In Bangladesh for R.C.C structure there is no floor limitation but for unavailable of hot –rolled section built up section used, only 6-7 stories thus.	Answer: Normally in Bangladesh pharmaceuticals steel buildings are built 6 <sup>th</sup> to 7 <sup>th</sup> floor.	Answer: In R.C.C 8 <sup>th</sup> to 10 <sup>th</sup> floor and 3 or 4 floor for steel.
06.	Was more manpower or equipment involved in the construction?	Answer: In Bangladesh comparatively more manpower uses than equipments for steel structure.	Answer: During R.C.C structure construction more labours are required than steel structure ,but  For steel structure construction more equipment and	Answer: R.C.C structure required more manpower than steel	Answer: Steel structure required almost same amount manpower

			mechanization are required.	structure.	like R.C.C structure but require more equipment.
07.	Was the seismic load taken into consideration during construction?	Answer: Steel is lighter than R.C.C structure, so there is no significant threat for seismic load.	Answer: During construction of R.C.C structure seismic loads are considered because it has heavy self weight, on the other hand seismic loads aren't considered in steel structure for lighter section.	Answer: Seismic loads are considered for R.C.C structure.	Answer: Seismic load effects R.C.C structure than steel structure for more self weight.
08.	What is the interval of maintenance?	Answer: Approximately two years maintenance interval for steel structure.	Answer: Maintenance is easier in steel than R.C.C structure. Normally two year maintenance interval for R.C.C structure.	Answer: Maintenance interval for outer periphery varies 12 to 18 months and for inner periphery maintenance is a routine task.	Answer: for steel structure maintenance at outer periphery takes one year and maintenance for inner periphery is a routine task.
09.	Was there any extension done?/Extension?	Answer: Extension of Steel is easier than R.C.C structure.	Answer: Extension of R.C.C structure. is difficult and costly than steel structure.	Answer: Extension done by R.C.C structure.	Answer: Extension done by steel structure.
10.	Level of difficulty than original structure?	Answer: Steel extension is easier than original structure.	Answer: Extension of R.C.C structure is not so difficult but require more time than steel.	Answer: R.C.C is comparatively difficult than original structure.	Answer: R.C.C is difficult but steel is easier, quick and economical.
11.	Which structure is safer?	Answer: Steel is safer than R.C.C building because it fails	Answer: R.C.C building fails suddenly due to construction faults or lack of quality control	Answer: R.C.C is safer	Answer: For pharmaceutical

		gradually.	but steel building fails very slowly so enough time to evacuate.	because it satisfy overall environmental impact on pharmaceutical building.	ical industry R.C.C structure is safer for intactness, fire resistant capacity and for good relative humidity.
12 ..	Was there any repaired work done? /repaired work?	Answer: For repairing works in steel structure is very easy, safe and quick..	Answer: Repairing work is so easy in steel structure comparatively than R.C.C structure.	Answer: Repaired work done by R.C.C structure.	Answer: Repaired work done by both structure but easy and quick in steel.

#### 4. Data analysis and Comparison

In any analytic study, the most important step is the collection of data. This study also requires data collection, which was conducted through a questionnaire survey and personal interviews. The following chapter includes this questionnaire and the data collected and organized in a tabular form. The table contains the comparative characteristics of both steel and R.C.C structures and thus indicates the better material for construction. It also shows the individual benefits and lacking of each material. Hence, it can be concluded that this chapter is the core of the whole study.

##### Comparison table:

Topic	R.C.C	Steel
Cost	Initial investment is moderate.	25% of the total cost must be paid as initial investment approximately 25-30% cost is saved compared to R.C.C. due to time. So more economic.
Time	More time required, lengthy process of work and delay during monsoon.	Faster construction usually completed within a month or two after the foundation has been completed.

Building self- weight	Concrete is very heavy thus higher self-weight for R.C.C. building.	Lesser self-weight compared to R.C.C thus formation size is smaller.
Safety during construction.	Less safe because the accident frequency is higher through the rate of fatal accident is very minimal. Also proper safety protocol is not always followed. Both for labourers and construction site.	Safer because the accident frequency is very less though massive and proper safety protocol is followed.
Vibration and earthquake resistance.	R.C.C frames are usually portal/ rigid frames. Thus vibrating loads affect the frame adversely also it has a higher self weight and due to construction falls failure during earthquake on other reason is severe and causes massive life loss.	Steel frames are usually gable/ flexible frames. So vibrating loads affects minimally also it has a lower self-weight and ductility, so failure during earthquake on other reason is gradual and many lives can be saved.
Flexibility and adaptability.	Long span without support is very very rare. Members are not replaceable or moveable once cast.	Long span (up to 200ft-250ft) can be constructed without any column support thus increasing the inner space of the structure. Any members or parts of the structure can be moved or replaced easily making it adaptable to any condition.
Strength and longevity.	R.C.C life span can be increased if constructed with strict quality control.	Strength of steel is high due to its high failure point and due to its yielding characteristics it must be also noted. Steel has a longer life span. Steel is strong both under compressive and tensile stresses.
Quality control during construction.	Quality control during R.C.C. construction is very difficult because the number of parameters where quality is needed are in numerous.	Quality control in steel construction is very easy. Because it involves only fabrication of pre-made members by welding or bolting.
Mechanization of construction.	R.C.C construction involves more labourers than equipments, more over the labourers need not require high skill levels and are cheap. The equipments needed are widely available and has moderate renting price.	Steel construction requires diverse and greater amount of equipments the renting price of equipments range from moderate to high. The labourers required must be highly skilled and usually trained by their seniors. No special training arrangement is available with the exception of large companies.

Maintenance repair Expansion	Maintenance of R.C.C. is difficult and sometimes very complicated. It may also happen that the newly constructed portion is not compatible and may be the reason of failure. Repair of R.C.C can be very diverse in nature. Thus the method may be complicated or easy, depending on the nature of the repair.	Maintenance of steel is very easy and interval is longer. Repair expansion and replacement is very easy. Temporary expansion or a light weight expansion is needed on the roof steel is preferred.
Resell value.	Negligible or nil.	Approximately 80 to 95 percent can be salvaged because the price of steel keeps increasing & almost all part of it recyclable.
Sustainability & Environmental impact	R.C.C is not recyclable moreover not bio-degradable, so R.C.C waste is a big problem for the environment and becomes uneconomic.	Steel is considered the greener material since it is recyclable and has minimal effect in environment.
Load condition design.	The load condition of R.C.C building is similar to steel design and design based on cross section.	Same to R.C.C building.
Aesthetics and intactness	R.C.C building is more aesthetic and is more intact than steel structure.	Aesthetically not good at all. If need to intact the steel structure than R.C.C structure is used.
Exceptional forms	Exceptional forms such that dome, arches, curves are difficult to build in R.C.C but they can carry load.	Easy to built but does not carry load.
Heat, humidity & chemical	Heat, Humidity and Chemical cannot create any effect in R.C.C structure. It is fire resistant.	Corrosion may be creating in the steel structure. It is not fire resistant.
Insulation	Need not be very precise, moreover the whole structure works as insulator itself.	Must be very precise.

## 5. APPROXIMATE COST VARIATION BETWEEN R.C.C AND STEEL STRUCTURE

Most of the industrialists in Bangladesh have no idea how construction cost can differ in between R.C.C and Steel structure, so they hesitate in making a decision about which structure is suitable for their industry. For their general knowledge, here we represent an approximate overall and per square feet construction cost estimation between these structures.

### STEEL STRUCTURE COST:

Area: 51100 sft. (Ground floor =18040sft + Typ.15590sft\*2=49220 sft)

#### A.Civil Works Cost Estimation (Foundation):

Item no.	Description of Item	Quantity	Unit	Unit Rate	Amount(Tk.)
1	Mobilization, Layout marking & Labour shed arrangement	18040.00	Sft	L.S	50,000
2	Pile driving upto 18.5m depth	5340.00	Rft	200	1,068,000
3	Pile R.C.C works with stone chips all complete excluding the cost of reinforcement & its fabrication	11750.00	Cft	300	3,525,000
4	Pile Head bracing	980.00	Cft	120	117,600
5	Pile cap	2850.00	Cft	360	1,026,000
6	Supplying ,fabrication etc. of MS Rod in R.C.C works in pile &pile cap:60 grade deformed bar	40450.00	Kg	90	3,640,500
7	Earth cutting up to 1.5 m depth	1570.00	Cft	5	7,850
8	300mm sand filling , levelling, dressing,& compaction of Ground for slope maintain.	122,000.00	Cft	28	3,416,000
9	One layer polythene laying in foundation and in floor	19450.00	Sft	3.75	72,937.5
10	One layer Brick flat soling in foundation or in floor	19450.00	Sft	38	739,100
Total Foundation cost =					13,662,987.5



**B. Civil works cost estimation (superstructure + other construction work):**

Item no.	Description of Item	Quantity	Unit	Unit Rate	Amount(Tk.)
1.	R.C.C works with brick chips using wooden shutter and prop complete excluding the cost of reinforcement and its fabrication				
	Column	1450	Cft	360	522,000
	Grade beams	1520	Cft	360	547,200
	Beam and lintel	990	Cft	360	356,400
	Lift core	700	cft	320	224,000
	Ramp & stair	120	Cft	320	38,400
	Ground floor	8950	Cft	320	2,864,000
	Typ. Floor	10,300	Cft	320	3,296,000
2	Supplying ,fabrication etc. of MS rod in R.C.C works in all floors :60 grade deformed bar	43500	Kg	90	3,915,000
3	250 mm Brick work in ground floor with 1 <sup>st</sup> class bricks in cement sand (F.M 1.2) mortar (1:4)	6685	Cft	200	1,337,000
4	12 mm thick plaster with NCF Below PL in proportion 1:5	4070	Sft	30	122,100
5	Minimum 12 mm thick cement sand (F.M 1.2) plaster (1:4)	12000	Sft	20	240,000
Total amount=					13,462,100.00

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Total civil works cost: BDT 27125087.50

**C.MAIN BUILDING ITEM:**

Item no.	Description of item	Weight (kg)	Amount (Tk.)
1	Superstructure cost: (i.e. Column, Rafter, Beam, including base plate ,joint plate, purlin & Girt, Nut bolts, cable bracing etc)	201,160.50	23,337,850.00
2	Sheeting & Accessories Cost: (i.e. Roof Sheet, Wall Sheet ,Decking panel, Capping Flashing, gutter, fasteners etc)	46,296.10	7,237,875.00
3	Erection cost: Erection of pre-engineered welded steel column, Rafter, Beam, purlin, Girt etc and Fitting & Fixing charge of roof & Wall sheeting, capping, Gutter, Down Pipe, Door ,Canopy, Window Frame, Louver etc.		919,800.00
Total weight (kg)=		247,456.60	
Total Main Building cost =			31,495,525.00

Total steel structure cost (civil works +main building) = BDT **58,620612.5**

Per square feet cost = BDT **1147.17**

**R.C.C STRUCTURE COST:**

Total area: 51,100 sft

Building type : Non –residential

Building category : i.GF =18040 sft

ii.Typ.=15590\*2=31180 Sft

Type of structure : R.C.C frame structure ( f'c= 19 to 21 Mpa )

Foundation : pile (cast- in situ), 3 storied.

Plinth area : 18040 sft ( 1676.9 sqm.)

**A.FOUNDATION COST:**

Item no.	Description of Item	Quantity	Unit	Unit Rate	Amount(Tk.)
	Soil Investigation	1676.9	Square meter	L.S	100000.00
	Foundation cost (Df=10 ft,with 12 inch basement slab& pile length 50 ft with 20 inch considered).	1676.9	Square meter	21387	35,863,860.30
	Add extra 2% cost for wind and Earthquake load				71704.244
Total foundation cost=					36,035,564.54

**B.SUPERSTRUCTURE COST:**

Item no.	Description of item	Quantity	Unit	Unit Rate	Amount(Tk.)
	Ground floor(NRRCBA2)	1676.9	Square meter	12624(standard)	21,169,185.60
	1 <sup>st</sup> Floor	1449.15	Square meter	12243(standard)	17,741,993.87
	2 <sup>nd</sup> Floor	1449.15	Square meter	12427(standard)	18,008,587.05
Total superstructure cost=					56,919,766.52

Total R.C.C structure cost: BDT **92,955,331.06**

Total R.C.C Structure per square feet cost (Foundation+ superstructure cost): BDT **1819.08**

**Result:** From above calculation we see for the same area, Steel structure approximate construction cost per square feet BDT 1147.17 and R.C.C structure approximate construction cost per square feet BDT 1819.08

## 6. Conclusion

The controversy regarding the choice of material will continue to exist as long as concrete and steel is used because both have some great advantages as well as disadvantages and both will continue to develop with the advancement of technology and techniques. It is evident from above discussion that steel must be chosen for less humid and hot areas, also it should be chosen for industries involved with no corrosive chemicals and that requires less intactness with respect to internal environment. While concrete must be chosen for hot and humid environments and for industries that require chemicals and a very intact internal atmosphere. Thus steel can be a good choice for building ware houses, silos, temporary light structure and concrete for the main production building. As Bangladesh is a developing country so in context of Bangladesh we strongly recommend steel structure to be implemented in industrial sector from economical point of view.

## 07. References

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