A Project on
Planning and Designing of a School building

Submitted in fulfillment of the Degree of

Bachelor of Technology

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WAKNAGHAT

Certificate

This is to certify that project report entitled "PLANNING AND DESIGNING OF SCHOOL BUILDING ", submitted by ABHISHEK JINDAL AND ARYA KUMAR RAI in fulfillment for the award of degree of Bachelor of Technology in Civil Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date:

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Acknowledgement

We take this opportunity to express my profound gratitude and deep regards to my guide Mr Lav Singh for his exemplary guidance, monitoring and constant encouragement throughout the course of this thesis. The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which we are about to embark.

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Abstract:

The planning and design of school building encompasses our project that is planning of the school according to NBC 2005 norms, designing of the proposed plan of school building. Then checking whether the designed school is stable or not using STAADPRO software and finding out the cost using cost estimation software (Estimator).

Anyone managing the construction process needs a basic understanding of the engineer’s environment and the basic understanding of how a structure behaves. Constructors must be able to address a number of technical questions at the project site including structural issues that sometimes are not addressed by the design professionals. Since the safety of construction workers as well as the strength and stability of structures during the construction phase is of paramount importance, construction managers need this knowledge.

There are a variety of software programs which are available for the different specialized disciplines of civil engineering. Most civil engineers practice in specialized subsets of civil engineering, such as geotechnical engineering, structural engineering, transportation engineering, hydraulic engineering, environmental engineering, project and construction management. STAAD or (STAAD.Pro) is the structural engineering professional’s choice for steel, concrete, timber, aluminum, and cold-formed steel design of virtually any structure including culverts, petrochemical plants, tunnels, bridges, piles, and much more through its flexible modeling environment, advanced features, and fluent data collaboration. STAAD.Pro allows structural engineers to analyze and design virtually any type of structure through its flexible modeling environment, advanced features and fluent data collaboration. Its wide use in the field of civil engineering makes it of an utter importance to learn.

Contents

List Of Figures

List of tables

CHAPTER 1: INTRODUCTION

1.1Planning

When thinking about planning of school from a constructors point of view certain factors need to be considered environmental factors, social factors and economical factors etc.

1.Goal setting: Plans are the means to achieve certain ends or objectives. Therefore, establishment of organizational or overall objectives is the first step in planning. Objectives provide the guidelines (what to do) for the preparation of strategic and procedural plans. One cannot make plans unless one knows what is to be accomplished. Objectives constitute the mission of an organisation.

2. Developing the planning premises: Before plans are prepared, the assumptions and conditions underlying them must be clearly defined these assumptions are called planning premises and they can be identified through accurate forecasting of likely future events.

3. Reviewing Limitations: The key areas of Imitations are finance," human resources, materials, power and machinery. The strong and weak points of the enterprise should be correctly assessed.

4.Deciding the planning period: The planning period should be long enough to permit the fulfilment of the commitments involved in a decision. This is known as the principle of commitment. The planning period depends on several factors e.g., future that can be reasonably anticipated, time required to receive capital investments, expected future availability of raw materials, lead time in development and commercialization of a new product, etc.

5.Preparing operating plans: These plans consist of procedures, programmers, schedules, budgets and rules. Such plans are required for the implementation of basic plans. These plans are helpful in the implementation of long range plans. Along with the supporting, plans, the timing and sequence of activities is determined to ensure continuity in operations.

1.2 TYPES OF SPACES

Ground floor Spaces :

- 12 Classrooms
- 4 Washrooms
- Principal Room
- Administration Room
- Dispensary
- Pantry
- Book Shop
- Canteen
- Library
- Computer Lab
- Store Room

First Floor Spaces :

- 8 Classrooms
- 4 labs
- Staff Room
- Multipurpose Hall
- Games Room
- 4 Washrooms
- Balcony

1.3 CBSE Norms

- School should have a min. area of 2 acres including academic block & playground.

- The pupil teacher ratio should not exceed 30:1 and section teacher ratio must be 1:1.5

- The minimum floor space should be at least 1 sq. mtr. per student.

- The number of student in the class should not be very large. The optimum number in a section of a class is 40.

- Computer Lab and Math Lab. No minimum size is prescribed, however the school should have separate provision for each. The computer lab should have 10 computers or computer student ratio of 1:20.

- Rooms for extracurricular activities-either separate rooms for music, dance, arts & sports or one multi-purpose hall for all these activities should be available.

CHAPTER 2 : LITERATURE REVIEW

2.1 Research

For planning and designing of school building. A constructive survey was conducted thus helped us to know various technical and other essential norms that are generally considered from architects point of view ,investors point of view and society view this helped us to build a perception about various terms and conditions that are needed to be kept in mind for such a construction process.

2.2 Process

- The survey which was made it included interaction and getting feedback from the management of a school situated in Bhatinda (Punjab) and Jammu (J&K).
- The principle of the school expressed his ideas and also shared the need importance and problems faced throughout existence of any school.
- After this we went for a detail inspection of the school building and this helped us to get into insight of an school foundation and layout. We went through each an every unit of school and gave a thorough look at the construction point of views.

Conclusion:

- After the research process got over many observation were made.

- In Des Raj school which is a goverement based school upto class 10^{th} which had total number of student 796.Number of teacher were 35. Total number of classroom were 19.Area of the school was 3500sq ft. Average number of sections were 3.Number of washrooms were 3 (both for boys and girls).Average classroom size was 13x26 ft and height of the classroom was 10 ft. student teacher ratio was 1:23.

- In Lord Rama Public school which is a private school it has a total number of students 3000. Number of teachers 110. Average student in each class were 40.average number of section were 4. Area of the school was 11,500sq ft.Number of classrooms were 56 Average classroom size was 15x20 ft. Height of the classroom was 12ft. student teacher ratio was 1:27.

2.3 Failures

Fig 2.1 Seepage Failure

Fig 2.2 Settlement Failure

Water seepage is a potential hazard to multi-story buildings worldwide. It has led to lots of civil actions and the Court general relies on expert opinion on the finding of facts. In establishing the cause of action, identification of the sources of water seepage is usually more important than that of the causes of water seepage. As for the internal of a building, bathroom is probably the area where majority of the water seepage problems occur. This is due to the use of sea-water in the flushing system. Thorough understanding of the causes of water seepage is useful to identity the appropriate means of repair. Applications of injection grouting or cementitious based material with ability of capillary action or in-depth crystal growth are recommended for the repair of concrete against water seepage.

CHAPTER 3 : PROJECT WORK

We are planning a school which will be made according to the NBC 2005 in plan region which will located 10 -15 km radius from the centre of the city. The school is easily accessible. School will be constructed on plan terrain which will be well compacted

1. We plan to Provide an interior environment that is visually comfortable and stimulating by providing ample natural light and incorporating colors that stimulate or soothe, depending on the space function.
2. Avoid glare and direct-beam sunlight.
3. Design for diffuse, uniform daylight throughout classrooms.
4. Use day lighting analysis tools to model the interaction of lighting and materials that reflect or absorb light.
5. Select building elements on the basis of life-cycle cost analysis—Mirror the lifespan of projects and systems with the expected lifespan of the facility.
6. Consider the recyclability of materials
7. Specify materials and products that are easy to maintain (balance this with their impact on children's health and the environment).
8. Use energy simulation and analysis tools to optimize energy performance (integrate day lighting systems, high-performance HVAC, energy-efficient building shell, and high-performance electric lighting)
9. Cluster classrooms around common areas.
10. Provide platform spaces for gathering, sitting, and presenting and alcoves for reading and studying.
11. Use operable walls to increase the efficiency of large, multipurpose spaces.
12. Accommodate technology upgrades.
13. Make day lighting a priority, especially in classrooms. Day lighting is the controlled admission of natural light into a space
14. Use natural ventilation when possible. (This and day lighting also provide a connection to the outdoors.)

15. Ensure superior indoor air quality
16. Connect the indoor environment to the outdoors by providing operable view windows in classrooms and easy access from classrooms to gardens and other outdoor areas that can be utilized in the curriculum.
17. Maximize visual access to corridors and school grounds
18. Increase occupants' sense of ownership and "territoriality" by providing comfortable, not institutional, rooms and by clearly defining the school boundaries.
19. Control access to the building and grounds by individuals and vehicles.
20. Use durable, non-toxic building materials
21. Use energy, water, and other resources efficiently.
22. Use of solar panels .
23. Integrate high-performance mechanical and lighting systems.
24. Provide opportunities for safe walking and bicycling to school.
25. Use the Green Building Concept.

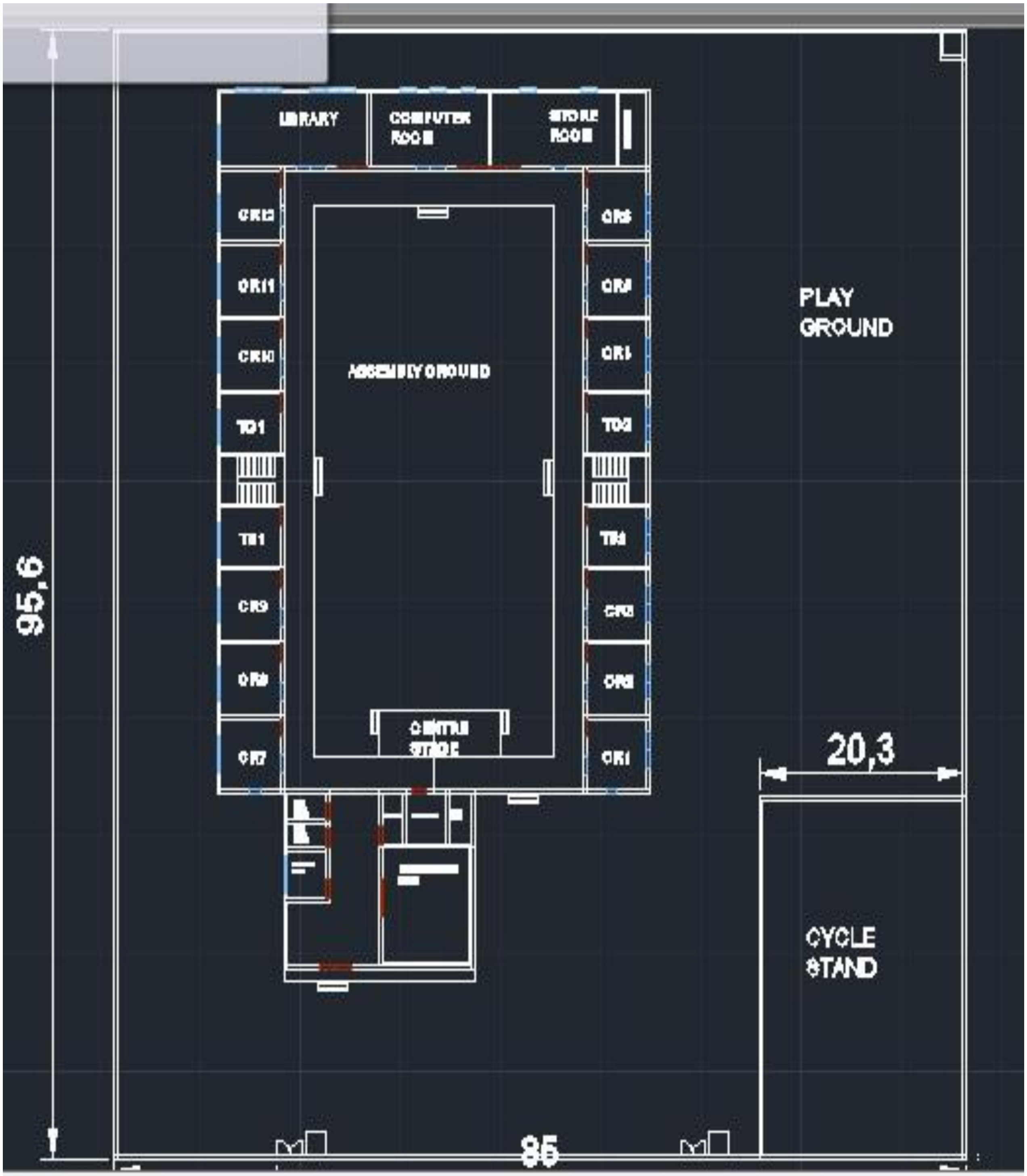

Fig 3.1 Autocad drawing of the planned school

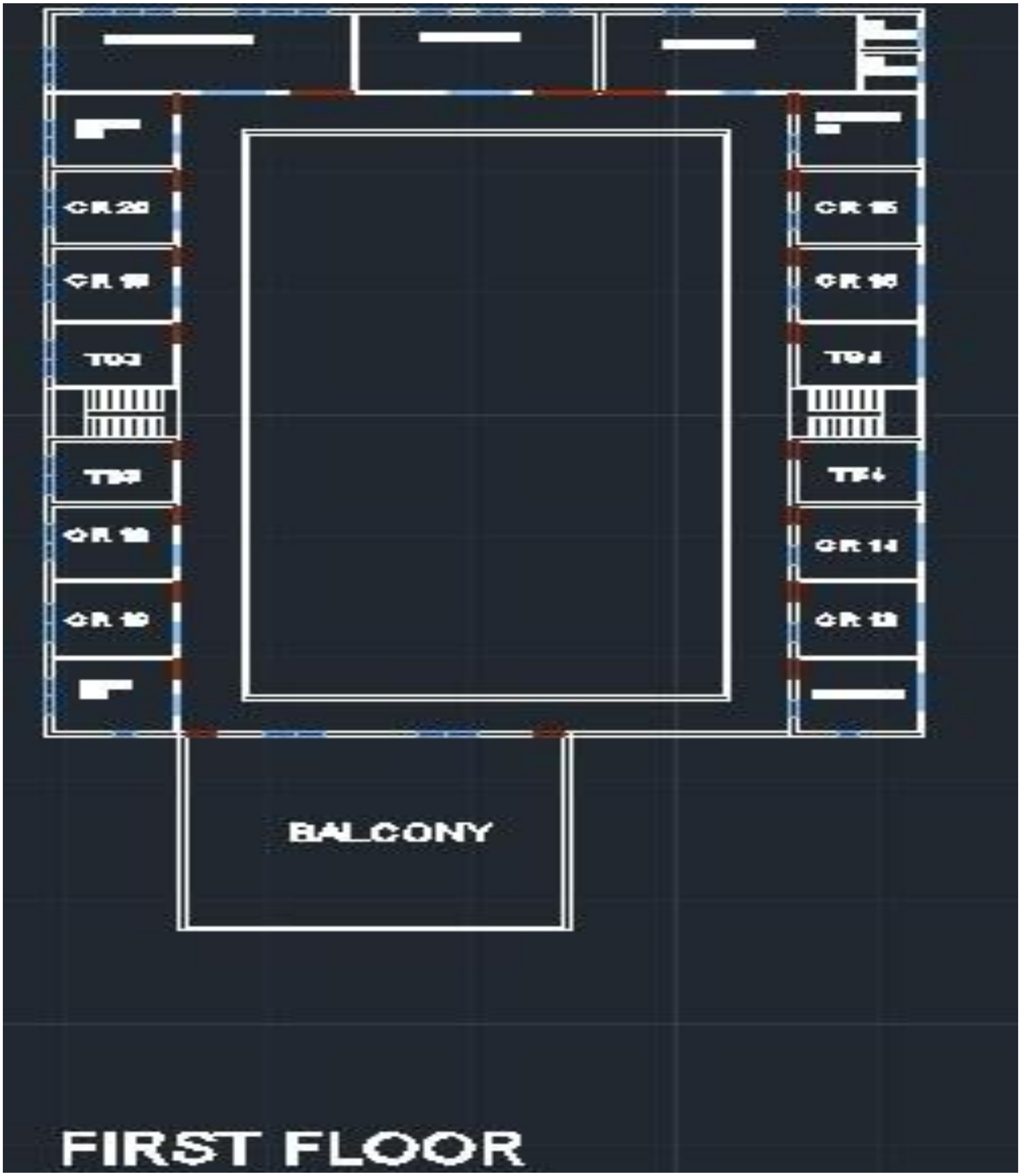

Fig 3.2 Autocad drawing of 1st floor

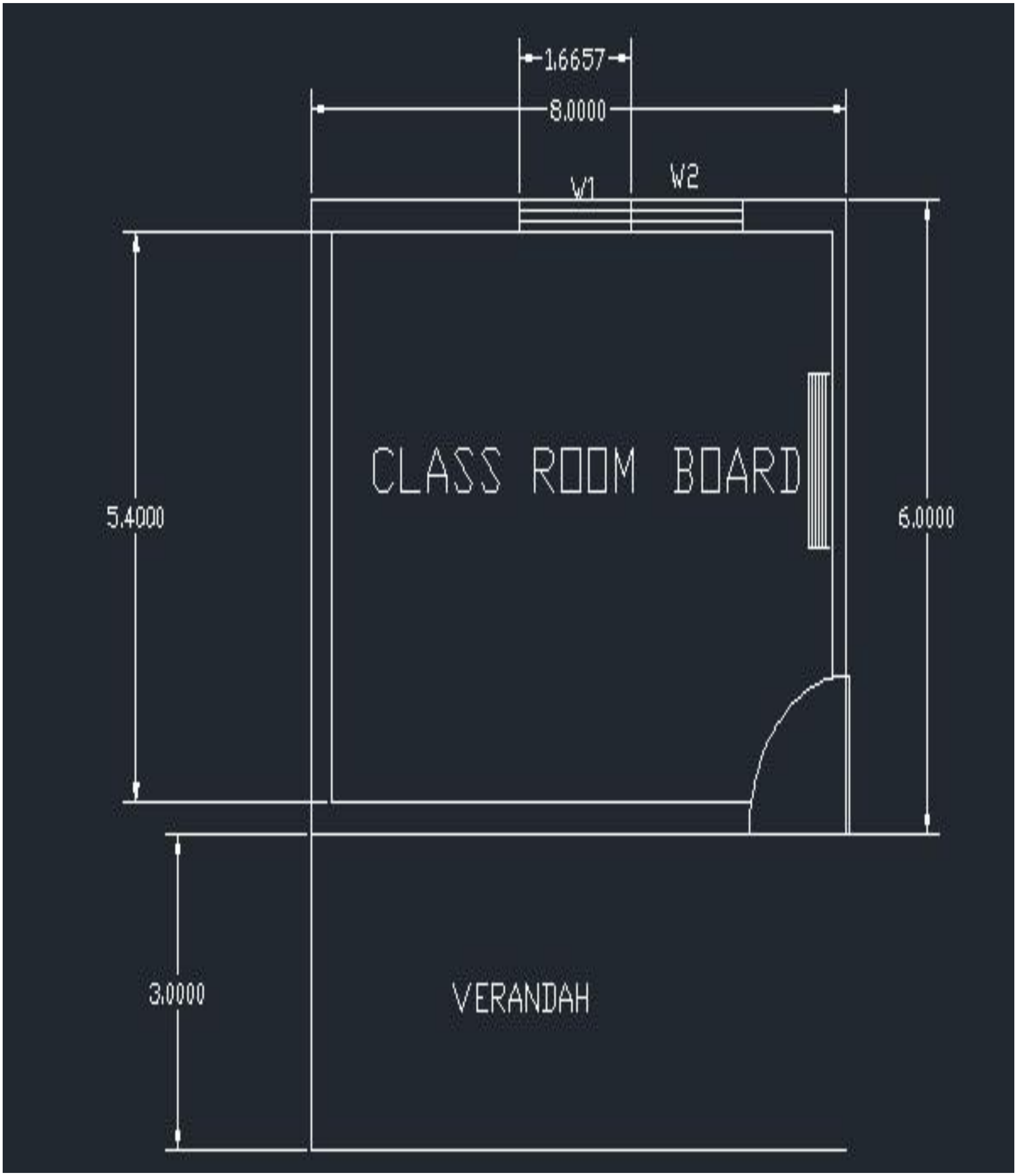

Fig 3.3 Autocad drawing of a class room

Fig 3.4 Autocad 3D modelling of ground floor

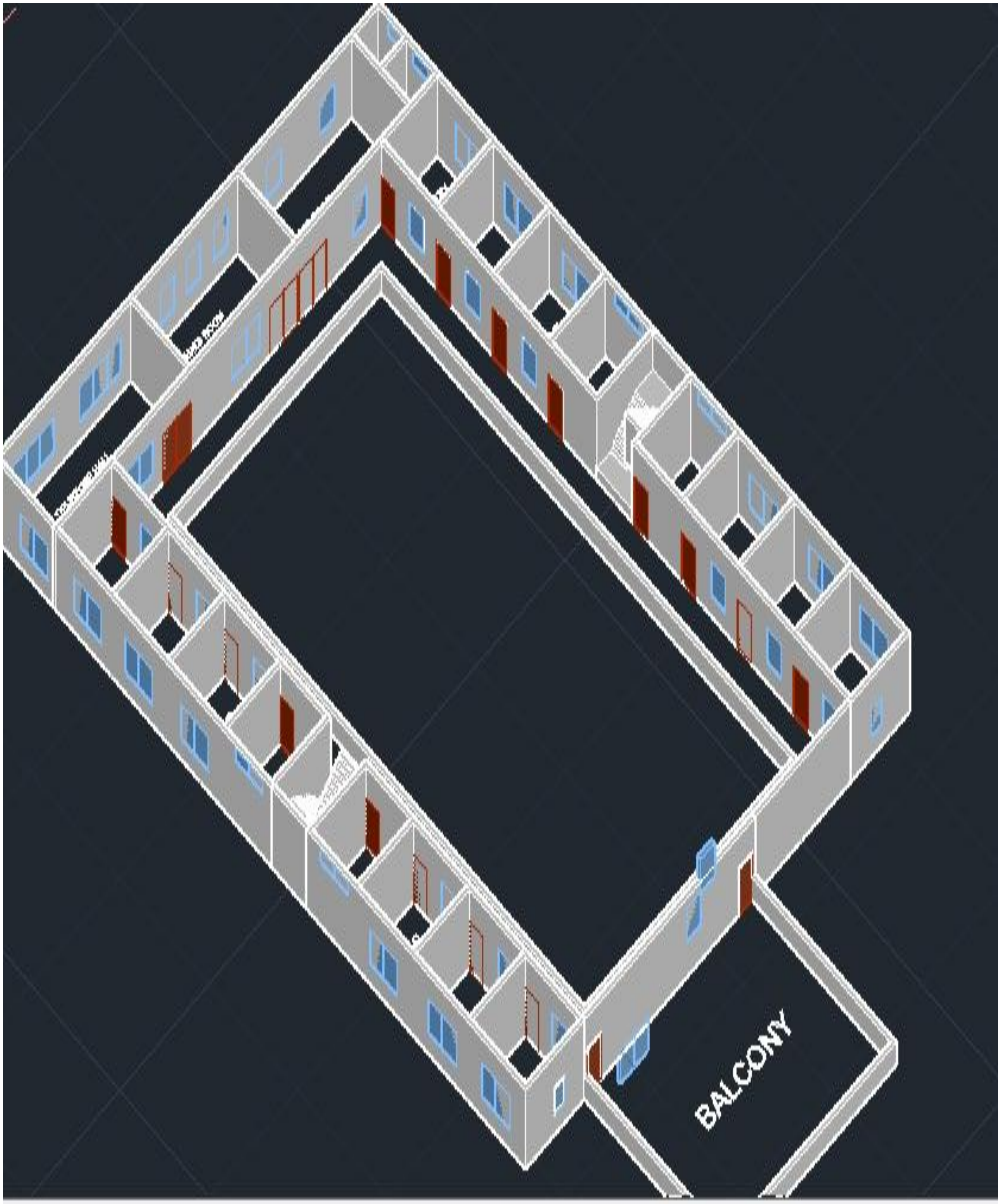

Fig 3.5 Autocad 3D modelling of the 1st floor

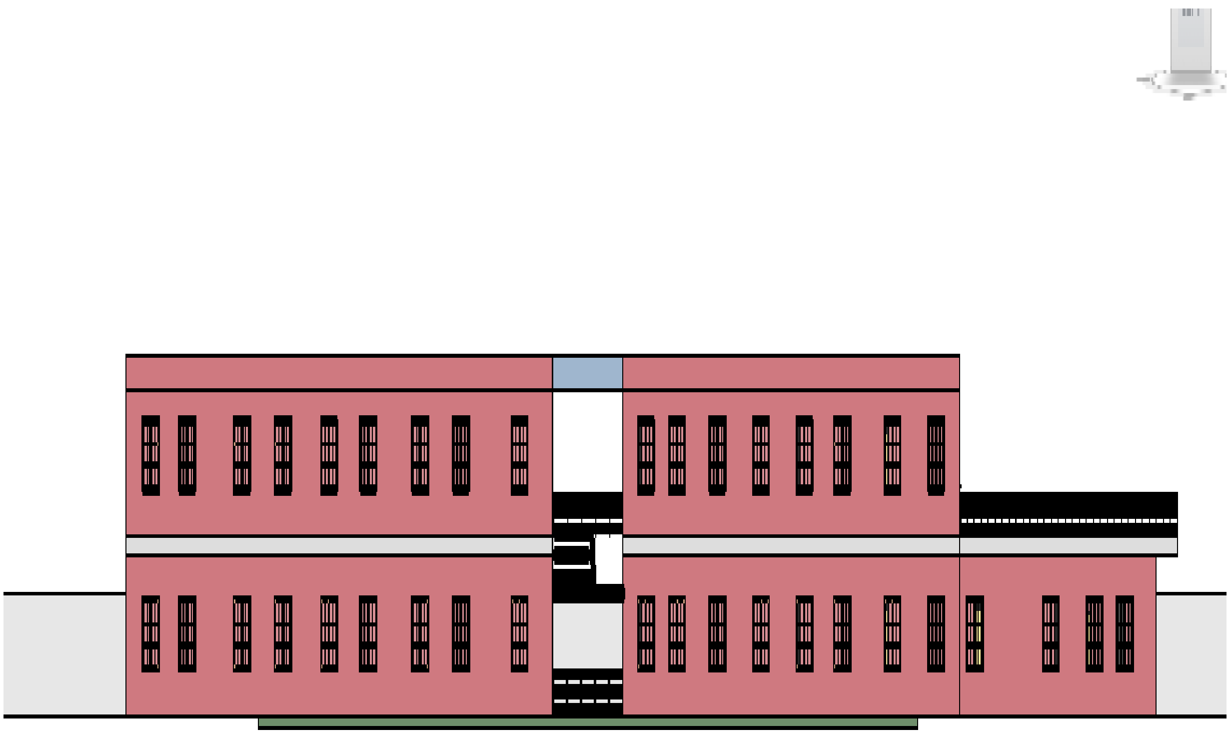

Fig (3.6) 3D side view of the school on Revit

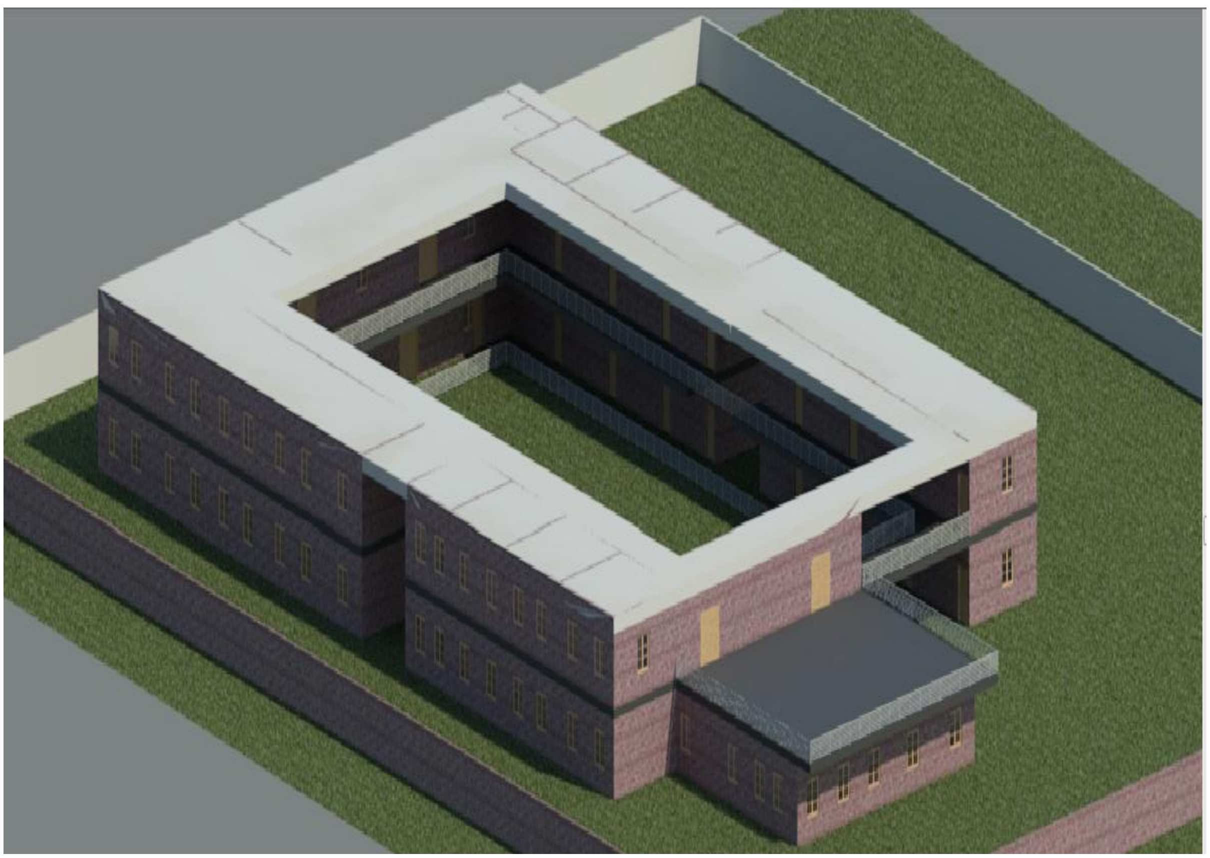

Fig (3.7) 3D view of the school on Revit

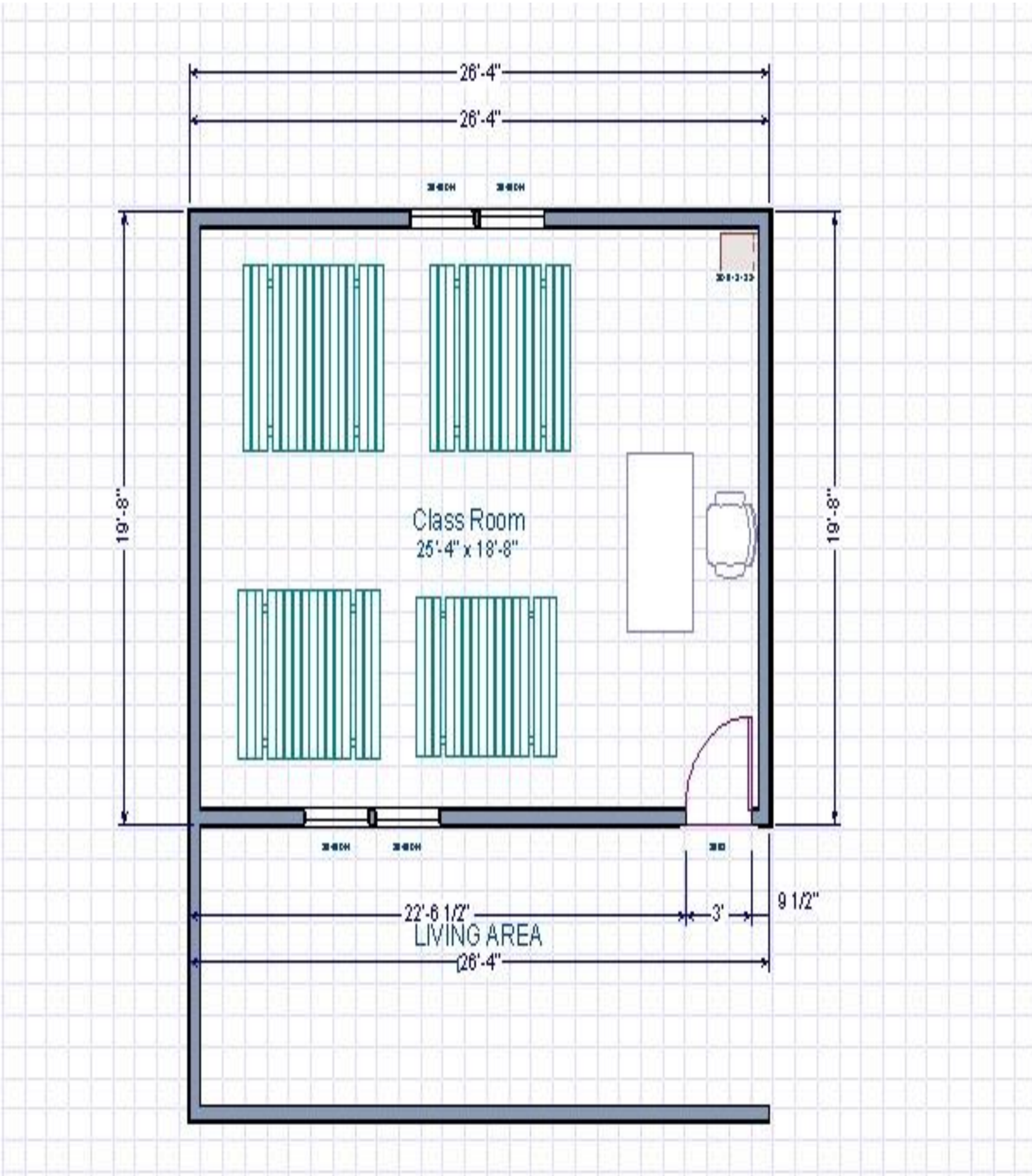

Fig (3.8) Drawing of a classroom On Chief Architect

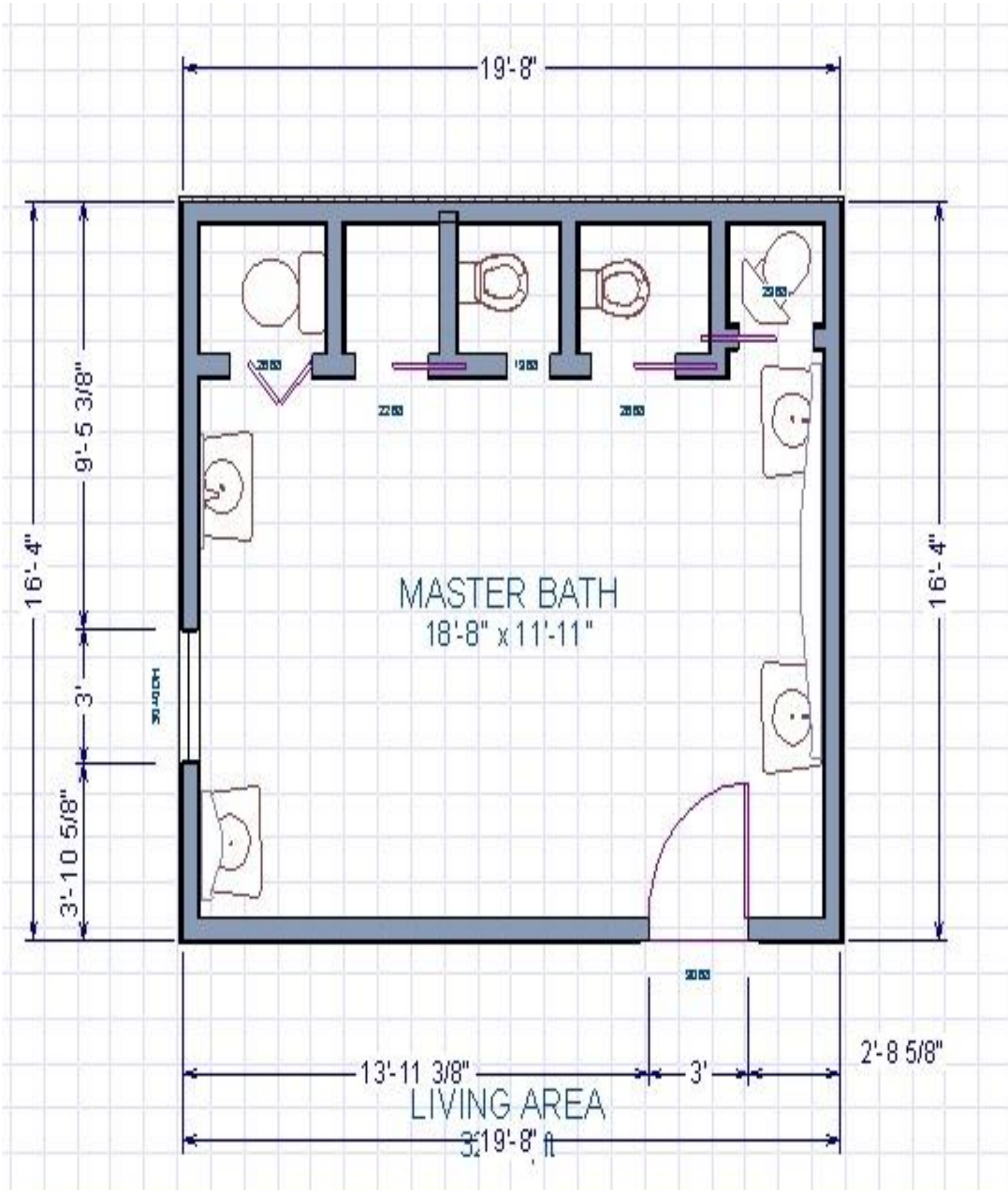

Fig (3.9) Drawing of a Toilet On Chief Architect

CHAPTER 4 : COST ESTIMATING

Project underestimation of resources and costs is one of the most common contributors to project failure. As such, project managers should be knowledgeable of and consider the various industry techniques and tools in the definition and execution of project cost estimation. As defined by the Project Management Body of Knowledge (PMBOK), cost estimation is the iterative process of developing an approximation of the monetary resources needed to complete project activities. Project teams should estimate costs for all resources that will be charged to the project. This includes but is not limited to:

- Labor
- Materials
- Equipment
- Services
- Software
- Hardware
- Facilities
- Contingency Costs

The following list includes common tools and techniques used in project cost estimation:

- Expert Judgment – use of knowledge gained from past project management experience. Expert judgment, in conjunction with objective estimation techniques, provides valuable information about the organizational environment and information from prior comparable projects.

- Analogous Estimating – use of the metrics from a previous, similar project as the basis of estimation for the current project. Analogous estimating takes the actual cost of previous, similar projects as a baseline and then adjusts for known differences (such as size, complexity, scope, duration, etc.).

• Parametric Estimating – use of a statistical relationship between historical data and other variables (for example, lines of code in software development) to calculate an estimate for activity parameters, such as scope, cost, budget, and duration. Used correctly, this technique can produce high levels of accuracy.

• Bottom-Up Estimating – estimating all individual work packages/activities with the greatest level of detail, summarizing higher-level estimates with the combination of the individual estimates. The accuracy of bottom-up estimating is optimized when individual work packages/activities are defined in detail.

• Three-Point Estimates – use of three estimates to determine a range for an activity's cost: the best-case estimate, the most likely estimate, and the worst-case estimate.

• Reserve Analysis – determination of contingency reserves to account for cost uncertainty.

• Project Management Estimating Software – use of project management cost estimating software applications, computerized spreadsheets, simulation, and statistical tools. Such tools can allow for rapid consideration of multiple cost estimate alternatives.

• Vendor Bid Analysis – determination of what the project should cost based on a review of vendor bids/proposals. This technique may be used in conjunction with other cost estimation techniques to ensure that cost estimates are comprehensive.

Whereas the execution of appropriate cost estimation techniques certainly contributes to the accuracy of cost estimates, other project management knowledge areas also play an important role in cost estimation accuracy. For example:

• Quality Management – If team members do not agree clearly upon deliverable quality criteria early in the project, they may take longer to meet expectations, unnecessarily resulting in a schedule delay and corresponding cost overruns.

• Communications Management – If team members do not clearly understand their roles and responsibilities on the project, project work may take longer to complete, thus delaying the schedule and increasing costs.

• Scope Management – If requirements are ambiguous, team members may deliver products that do not meet expectations, resulting in unnecessary rework, schedule delays, and corresponding cost overruns.

• Human Resource Management – If team personnel do not possess the required skills or experience to perform project work, it may take them longer to complete the work, causing schedule delays and cost overruns.

• Risk Management – If team members do not proactively conduct risk management, cost-impacting issues that could have been prevented may emerge.

• Procurement Management – If procurements do not include terms and conditions that proactively mitigate State risk (such as fixed-price contracts and deliverable acceptance criteria), the project may experience increased costs later in the project due to changing project and market conditions.

• Time Management – If team members do not accurately estimate the time to perform activities, the project may experience schedule delays and cost overruns.

4.1 CALCULATION OF COST ESTIMATION

ESTIMATION OF FOUNDATION (ISOLATED FOOTING)

Earthwork in excavation :

	no.	l	b	h
long wall	2	8.6	0.8	0.6
short wall	2	6	0.8	0.6
footing slab	1	3.2	3.2	0.6

	quantity(m^3)	Rate per unit (in Rs)	Cost of Excavation(Rs)
long wall	8.256	3.5	28.896
short wall	5.76	3.5	20.16
footing slab	6.144	3.5	21.504
Total cost of excavation of Classroom =			70.56

Calculating Steel:

Data:

Main steel Fe415 10mm dia 36 bars

	length	no. of bars	total length (m)	dia.(mm)
Longitudnal Steel	3.2	36	115.2	10
Transverse Steel	3.2	30	96	10

	quantity Kg (d^2/162) per m	total quantity(kg)	Cost per Kg	**Total cost in Rs**
Longitudnal Steel	0.61	70.272	32	2248.704
Transverse Steel	0.61	58.56	32	1873.92
			Total cost of steel in slab	4122.62

Table 4.1 Estimation of foundation of footing

Calculating Concrete:

Data:

M20 grade

Volume of footing	6.144	m^3

Material	quantity (m^3)	density(kg/m^3)	total quantity (kg)
Cement	1.12	1440	1612.8 (32.25bags)
Sand	1.68		
Aggregate	3.35	1700	5695

	price per unit	**Total cost in Rs**
Cement	280	9030
Sand	1050	1764
Aggregate	0.5	2847.5

Total cost of concrete	13641.5
Total cost of steel	4122.62
Total cost of excavation (in classroom slab)	70.56
Total cost of foundation of a Isolated Footing	17834.68

Table 4.2 Estimation of foundation of footing

BRICK WORK AND FINISHING FOR CLASS ROOM

		no.	l	b	h	quantity (m^3)
Brickwork :						
	long wall	2	8.6	0.3	3.65	18.834
	short wall	2	6	0.3	3.65	13.14
					Total	31.974
Deductions						
	DOOR	1	1.5	0.3	2.2	0.99
	WINDOW W1	1	3	0.3	1.5	1.35
	WINDOW W2	1	1.5	0.3	1.5	0.675
					Total	3.015
lintel						
	door	1	1.8	0.3	0.15	0.081
	window w1	1	3.3	0.3	0.15	0.1485
	window w2	1	1.8	0.3	0.15	0.081
					Total	0.3105

Total quantity after deductions 28.6485

Cost of brick work per cubic meter = Rs. 2370

Total Cost of brick work = 2370*28.6485 = Rs. 67896.55
of a classroom

Finishing :

		no.	l	b	h	quantity (m^3)
	long wall	2	8		3.25	52
	short wall	2	6		3.25	39
	roof	1	8	6		48
					Total	139

Deductions		no.	l	b	h	quantity (m^3)
	door	1	1.5		2.2	3.3
	window w1	1	3		1.5	4.5
	window w2	1	1.5		1.5	2.25
					Total	10.05

Total quantity after deductions 128.95

Cost of plastering per sq. meter = Rs. 22.5

Cost of painting per sq. meter = Rs. 7.5

Total cost = Rs. 30

Total cost for both painting and plastering = 128.95*30 = Rs. 3868.5

**Total Cost of a Brickwork and Finishing = Rs. 67896.55+3868.5 = Rs. 71765.05
of a Classroom**

Table 4.3 Estimation of Brickwork and Finishing of Classroom

ESTIMATION OF SLAB (CLASSROOMS)

DIMENSIONS	in meters		
length	6		
breadth	8		
depth	0.15		
volume	7.2	cub.m	
Calculating Steel:			
% tension r/f =	0.61		
Area of steel(0.61*b*d/100) =	0.0054	sq.m	
Volume of Steel =	0.0432	cub.m	
Density of steel =	7500	kg/m^3	
So, volume of Steel used =	324	kg	
Price of Steel per kg =	32.5		
Total price of steel used =	10530		
Calculating Concrete:			
Data:			
M20 grade			
Volume of Slab	7.2	m^3	
Material	quantity (m^3)	density(kg/m^3)	total quantity (kg)
Cement	1.31	1440	1886.4(37.72bags)
Sand	1.96		
Aggregate	3.93	1700	6676.36
	price per unit	**Total cost in Rs**	
Cement	280	10561.6	
Sand	1050	2061.82	
Aggregate	0.5	3338.18	
	Total cost of concrete	15961.60	
	Total cost of steel (used in classrooms)	10530	
	Total Cost of Slab of a classroom	26491.6	

Table 4.4 Estimation of Slab

ESTIMATION OF BEAMS

DIMENSIONS	in meters
length	6
breadth	0.3
depth	0.6

Calculating Steel:

Data:		
Main steel	Fe415	22mm dia 6 bars
Shear Reinforcement		8mm dia 21 stirups
spacing 280mm c/c		

length of shear stirup= 242*2+542*2+5d*2 = 1648 mm

	length	no. of bars	total length	dia.(mm)
main steel estimation	6	6	36	22
Shear Reinforcement	1.648	21	34.6	8

	quantity Kg (d^2/162) per m	total quantity(kg)	Cost per Kg	**Total cost in Rs**
main steel estimation	2.98	107.28	41.5	4452.12
Shear Reinforcement	0.39	13.49	42.7	576
			Total cost of steel in a beam	5028

Table 4.5 Estimation of Beam

Calculating Concrete:

Data:			
M20 grade			
Volume of beam	1.08	m^3	
Material	quantity (m^3)	density(kg/m^3)	total quantity(kg)
Cement	0.216	1440	311.04 (6.22bags)
Sand	0.324		
Aggregate	0.648	1700	1101.6
	price per unit	**Total cost in Rs**	
Cement	280	1741.82	
Sand	1050	340.2	
Aggregate	0.5	550	
	Total cost of concrete	2632.02	
	Total cost of steel	5028	
	Total cost of a beam	7660.02	

Table 4.6 Estimation of Beam

ESTIMATION OF COLUMNS

DIMENSIONS	in meters
length	3.65
breadth	0.45
depth	0.45

Calculating Steel:

Data:		
Main steel	Fe415	16mm dia 8 bars
Shear Reinforcement		6mm dia 14 stirups
spacing 280mm c/c		

length of shear stirup = 386*4 +5d*2 = 1604 mm

	length	no. of bars	total length	dia.(mm)
main steel estimation	3.65	8	29.2	16
Shear Reinforcement	1.604	14	22.45	6

	quantity Kg (d^2/162) per m	total quantity(kg)	Cost per Kg	**Total cost in Rs**
main steel estimation	1.6	46.72	40.7	1901.5
Shear Reinforcement	0.22	4.93	44.68	220.27
			Total cost of steel in a column	2122

Table 4.7 Estimation of Column

Calculating Concrete:

Data:			
M20 grade			
Volume of Column	0.739125	m^3	

Material	quantity (m^3)	density(kg/m^3)	total quantity (kg)
Cement	0.134	1440	192.96 (3.85bags)
Sand	0.2		
Aggregate	0.4	1700	680

price per unit	**Total cost in Rs**
280	1080
1050	210
0.5	340

Total cost of concrete	1630
Total cost of steel	2122
Total cost of a column	3752

Table 4.8 Estimation of Column

BRICK WORK AND FINISHING FOR WASHROOMS

Brickwork :

		no.	l	b	h	quantity (m^3)
	long wall	2	6.6	0.3	3.65	14.454
	short wall	2	5	0.3	3.65	10.95
					Total	25.404
DEDUCTIONS						
	DOOR	1	1	0.3	2.2	0.66
	WINDOW W1	1	3	0.3	1	0.9
					Total	1.56
Lintel						
	door	1	1.3	0.3	0.15	0.0585
	window w1	1	3.3	0.3	0.15	0.1485
					Total	0.207
			Total quantity after deductions			23.637

Cost of brick work per cubic meter = Rs. 2370

Total Cost of brick work = 2370*23.637 = Rs. 56019.69

Finishing :

		no	l	b	h	quantity (m^3)
	long wall	2	6		3.25	39
	short wall	2	5		3.25	32.5
	roof	1	6	5		30
					Total	101.5
Deduction		no	l	b	h	quantity (m^3)
	door	1	1		2.2	2.2
	window w1	1	3		1	3
					Total	5.2
		Total quantity after deductions				96.3

Cost of plastering per sq. meter = Rs. 22.5

Cost of painting per sq. meter = Rs. 7.5

Total cost = Rs. 30

Total cost for both painting and plastering = 96.3*30 = Rs. 2889

Total Cost of a Brickwork and Finishing = Rs. 56019.69+2889 = Rs. 58908.69
For a Washroom

Table 4.9 Estimation of Brickwork and Finishing of Washrooms

BRICK WORK AND FINISHING FOR LIBRARY

		no.	l	b	h	quantity (m^3)
Brickwork :						
	long wall	2	15.3	0.3	3.65	33.507
	short wall	2	6.3	0.3	3.65	13.797
					Total	47.304
Deductions						
	DOOR	2	1.5	0.3	2.2	1.98
	WINDOW W1	2	3	0.3	1.5	2.7
	WINDOW W2	2	4.5	0.3	1.5	4.05
					Total	8.73
lintel						
	door	2	1.8	0.3	0.15	0.162
	window w1	2	3.3	0.3	0.15	0.297
	window w2	2	4.8	0.3	0.15	0.432
					Total	0.891

Total quantity after deductions 37.683

Cost of brick work per cubic meter = Rs. 2370

Total Cost of brick work = 2370*37.6 = Rs. 89112

of a Library

Finishing :

		no.	l	b	h	quantity (m^3)
	long wall	2	14.7		3.65	107.31
	short wall	2	6.3		3.65	45.99
	roof	1	14.7	6.3		92.61
					Total	245.91
Deductions		no.	l	b	h	quantity (m^3)
	door	2	1.5		2.2	6.6
	window w1	2	3		1.5	9
	window w2	2	4.5		1.5	13.5
					Total	29.1

Total quantity after deductions 216.81

Cost of plastering per sq. meter = Rs. 22.5

Cost of painting per sq. meter = Rs. 7.5

Total cost = Rs. 30

Total cost for both painting and plastering = 216.8*30 = Rs. 6504

Total Cost of a Brickwork and Finishing = Rs. 89112+6504 = Rs. 95616 of a Library

Table 4.10 Estimation of Brickwork and Finishing of Library

BRICK WORK AND FINISHING FOR COMPUTER LAB

		no.	l	b	h	quantity (m^3)
Brickwork :						
	long wall	2	12.3	0.3	3.65	26.937
	short wall	2	6.3	0.3	3.65	13.797
					Total	40.734
Deductions						
	DOOR	2	1.5	0.3	2.2	1.98
	WINDOW W1	3	1.5	0.3	1.5	2.025
	WINDOW W2	1	3	0.3	1.5	1.35
					Total	5.355
lintel						
	door	2	1.8	0.3	0.15	0.162
	window w1	3	1.8	0.3	0.15	0.243
	window w2	1	3.3	0.3	0.15	0.1485
					Total	0.5535

Total quantity after deductions	34.8255
Cost of brickwork per cub.m(Rs)	2370
Total Cost of Brickwork (Rs.) of computer lab	82536

Finishing :

		no.	l	b	h	quantity (m^3)
	long wall	2	11.7		3.65	85.41
	short wall	2	6.3		3.65	45.99
	roof	1	11.7	6.3		73.71
					Total	205.11

		no.	l	b	h	quantity (m^3)
Deductions						
	door	2	1.5		2.2	6.6
	window w1	3	1.5		1.5	6.75
	window w2	1	3		1.5	4.5
					Total	17.85

Total quantity after deductions 187.26

Cost of plastering per sq. meter = Rs. 22.5
Cost of painting per sq. meter = Rs. 7.5
Total cost = Rs. 30

Total cost for painting and Plastering (Rs) 5617.8

Total Cost For Brickwork and Finishing (Rs) = For Computer Lab **88154**

Table 4.11 Estimation of Brickwork and Finishing of Computer Lab

BRICK WORK AND FINISHING FOR STORE ROOM

Brickwork :		no.	l	b	h	quantity (m^3)
	long wall	2	13.1	0.3	3.65	28.689
	short wall	2	6.3	0.3	3.65	13.797
					Total	42.486
Deductions						
	DOOR	2	1.5	0.3	2.2	1.98
	WINDOW W1	3	1.5	0.3	1.5	2.025
	WINDOW W2	0	3	0.3	1.5	0
					Total	4.005
lintel						
	door	2	1.8	0.3	0.15	0.162
	window w1	3	1.8	0.3	0.15	0.243
	window w2	0	3.3	0.3	0.15	0
					Total	0.405

Total quantity after deductions =	38.076
Cost of brickwork per cub.m(Rs)=	2370
Total Cost of Brickwork (Rs.)= of Store room	90240

Finishing :

		no.	l	b	h	quantity (m^3)
	long wall	2	12.5		3.65	91.25
	short wall	2	6.3		3.65	45.99
	roof	1	12.5	6.3		78.75
					Total	215.99
Deductions		no.	l	b	h	quantity (m^3)
	door	2	1.5		2.2	6.6
	window w1	3	1.5		1.5	6.75
	window w2	0	3		1.5	0
					Total	13.35

Total quantity after deductions 202.64

Cost of plastering per sq. meter = Rs. 22.5
Cost of painting per sq. meter = Rs. 7.5
Total cost = Rs. 30

Total cost for painting and Plastering (Rs) 6079.2

Total Cost For Brickwork and Finishing (Rs) = For Store Room **96319**

Table 4.12 Estimation of Brickwork and Finishing of Store Room

BRICK WORK AND FINISHING FOR ADMIN. ROOM

		no.	l	b	h	quantity (m^3)
Brickwork :						
	long wall	2	10.6	0.3	3.65	23.214
	short wall	2	8.6	0.3	3.65	18.834
					Total	42.048
Deductions						
	DOOR	2	1.5	0.3	2.2	1.98
	WINDOW W1	4	1.5	0.3	1.5	2.7
	WINDOW W2	0	3	0.3	1.5	0
					Total	4.68
lintel						
	door	2	1.8	0.3	0.15	0.162
	window w1	4	1.8	0.3	0.15	0.324
	window w2	0	3.3	0.3	0.15	0
					Total	0.486

Total quantity after deductions =	36.882
Cost of brickwork per cub.m(Rs)=	2370
Total Cost of Brickwork (Rs.)= of Administration Room	87410

Finishing :

		no.	l	b	h	quantity (m^3)
	long wall	2	10		3.65	73
	short wall	2	8.6		3.65	62.78
	roof	1	10	8.6		86
					Total	221.78
Deductions		no.	l	b	h	quantity (m^3)
	door	2	1.5		2.2	6.6
	window w1	4	1.5		1.5	9
	window w2	0	3		1.5	0
					Total	15.6

Total quantity after deductions 206.18

Cost of plastering per sq. meter = Rs. 22.5
Cost of painting per sq. meter = Rs. 7.5
Total cost = Rs. 30

Total cost for painting and Plastering (Rs) 6185.4

Total Cost For Brickwork and Finishing (Rs) = For Administration Room **93596**

Table 4.13 Estimation of Brickwork and Finishing of Administration Room

4.2 RESULTS OF COST ESTIMATION

Description	Cost (in Rs.)
1. Cost Estimation of Foundation of a Isolated Footing	17835
2. Cost Estimation of Brickwork and Finishing of a Classroom	71765
3. Cost Estimation of a Column	3752
4. Cost Estimation of a Beam	7660
5. Cost Estimation of Slab per sq. meter	550
6. Cost Estimation of Brickwork and Finishing of a Washroom	58909
7. Cost Estimation of Brickwork and Finishing of a Library	95616
8. Cost Estimation of Brickwork and Finishing of a Computer Room	88154
9. Cost Estimation of Brickwork and Finishing of a Store Room	96319
10. Cost Estimation of Brickwork and Finishing of a Administration Room	93596

Table 4.14 Results of Cost Estimation

4.3 TOTAL PROJECT COST

- Total Cost of Isolated Footings = Rs 1498056
- Total Cost of a Library = Rs 95616
- Total Cost of a Computer Lab = Rs 88154
- Total Cost of Store Room = Rs 96319
- Total Cost of a Administration Room = Rs 93596
- Total Cost of Columns = Rs 315168
- Total Cost of Beams = Rs 2811220
- Total Cost of Classrooms = Rs 1442000
- Total Cost of Labs = Rs 288400
- Total Cost of Washrooms = Rs 473360
- Total Cost of Multipurpose Hall = Rs 95616
- Total Cost of Games Room = Rs 88154
- Total Cost of a Staff Room = Rs 96319
- Total cost of Slabs = Rs 1429343

- **So, Overall Structural Cost of the Project = Rs 8911321**

CHAPTER 5 : GREEN BUILDING

A "green school" is an energy efficient, higher performing school that can be environmentally beneficial, economical to build and operate, and offer improved learning environments. The topic of green schools is increasing in importance, driven by greater environmental awareness and rising energy and operation costs.

This is often the first question asked, and one for which there is no simple answer. There is no commonly held Green School standard or definition. To confuse things further, the terms "green", "healthy", "sustainable," and "high performance" are often used interchangeably. However, there are several principles that frequently reoccur in Green School definitions: protecting the environment, lowering operating costs, improving the health and quality of the learning environment, and integrating learningopportunities with the built environment.

5.1 Why Green Our Schools?

1.Energy Efficiency:

With demonstrable operational cost savings and reduction of environmental impact, energy efficiency should be the first consideration for any Green School. Significant cost savings can be achieved from available and relatively low-cost, efficient technologies. Emissions from energy use also represent one of the largest impacts any school will have on the environment.

2. Financial Sustainability:

Building a Green School (depending on the green features pursued) can add 5% to 10% to the initial cost. This scale of incremental cost can be quickly recovered from lower operating costs that will continue over the life of the building.

3. Demonstrating Environmental Sustainability: The building of Green Schools is a tangible way for the education sector to show what can and is being done with respect to energy conservation, reducing greenhouse-gas and smog emissions, reducing water use and improving water quality, diverting material from landfill, saving topsoil and native-species habitat, promoting active transportation.

4. Supporting Student Achievement:

Green Schools support student achievement in three ways. They can save money from operations that can be redirected to the classroom. They can provide teaching environments that are more conducive to learning - through improvements in acoustics, lighting, temperature and air quality.

5.2 STEPS TO A GREEN SCHOOL

1.Draft the Green Team:

Developing a green school starts with the team.It may begin as a committee of school board staff, and grow to include other stakeholders and consultants. Many kinds of expertise are needed in building the green school: school board staff from all departments; building users; specialized green consultants; energy modelers; commissioning agents. Start by assessing the available in-house resources, and augment the team with outside resources that can include consultants and staff from government agencies or non-profits.

2. Define Green Objectives:

There may be a temptation to focus on implementing individual highly-visible green "features " or technologies. Generally, however,a more comprehensive approach based on multiple green objectives is a more successful strategy. One that balances experimentation with a more measured approaches. An environmental improvement of 10% over 20 schools results in a greater net benefit for the environment than an improvement of 90% in a single school. An improvement of 10% in 20 schools is also more likely to be achievable than a single 90% improvement. Setting initially low, achievable objectives that increase over time (as skills and experience are gained) is generally a lower risk strategy than implementing a number of one-off far reaching green features.

3. Set a Whole Life Building Budget:

With a definition of "green" and draft green objectives in place, the next task is to set a whole life budget. Budgets should consider costs over the entire life of the building. A board that saves on construction costs, only to incur higher long term operation and maintenance costs, has not realized any savings at all. School boards should consider a reasonable payback period for any premium over the base construction budget. For example, the construction budget could be set at the provincial benchmark with a maximum payback of 10 years on any premium items.Budgeting may also include non-monetary items,such as carbon-emission reduction and water conservation.

4. Refine the Green Objectives:

Once the whole life budget has been determined,the green objectives should be reviewed and specific green strategies discussed. A method of tracking and monitoring adherence to the green objectives should also be established at this point. The board may want to consider the use of one of the many green building rating tools or develop its own tracking method.Regardless of the method, what is important is that the green progress can be tracked and that any changes can be explained and understood by all the stakeholders while remaining flexible enough to take advantage of unexpected green synergies that may emerge through design and construction.

5. Select a Green Site:

Often a school site is simply designated by the developer, and the board may not have much influence over the location. Boards should still seak to engage developers and municipal officials early in the process to identify the best location for a new school site. When a board does have a choice, it should select a site which will support defined green objectives. Criteria can include a site that is within walking distance of a majority of students, supports compact urban form,is located on or near public transit routes, is connected to a walking or bike path system, is adjacent to a public park, etc.

6. Green Design and Construction Methods:

There are a broad range of green design elements that can be incorporated into a school, starting with energy efficient strategies. Energy efficiency provides predictable operation cost savings with relatively short payback periods for small initial investments. This list of six measures that combined will typically yield a 30% energy savings:

• ventilation heat recovery

• improved building envelope

• high-efficiency lighting design

5.3 RAIN WATER HARVESTING

Rainwater harvesting is an extremely effective water management solution that can reduce water consumption by up to 50-70%.

The volume of the storage tank can be determined by the following factors:

1.Catchment: The surface that receives rainfall directly is the catchment of rainwater harvesting system. It may be terrace, courtyard, or paved or unpaved open ground. The terrace may be flat RCC/stone roof or sloping roof. Therefore the catchment is the area, which actually contributes rainwater to the harvesting system**.** Type of roofing material determines the selection of the runoff coefficient for designs. Size could be assessed by measuring the area covered by the catchment i.e., the length and horizontal width.Larger the catchment, larger the size of the required cistern (tank).

2. The greater the number of people, the greater the storage capacity required to achieve the same efficiency of fewer people under the same roof area.

3. Per capita water requirement: This is based on habits and also from season to season. Consumption rate has an impact on the storage systems design as well as the duration to which stored rainwater can last.

4. Average annual rainfall

5. Period of water scarcity: Apart from the total rainfall, the pattern of rainfall -whether evenly distributed through the year or concentrated in certain periods will determine the storage requirement. The more distributed the pattern, the lesser the size.

5.4 DESIGNING OF WATER TANK

- Combined area of 1 multipurpose room, 1 game room, staff room & 2 washrooms = 43*7 m^2 = 301 m^2
- Combined area of 2 classrooms, 1 lab and 1 washroom=52*8 m^2=416 m^2
- Area of balcony = 19.1*16 = 305 m^2
- Area of cycle-stand = 30.3*20.3 =615 m^2
- Total rooftop area=301+416+416+305+615 m^2 =2053 m^2
- Average annual rainfall is 611 millimetres (mm). (As per data given in Appendix A)
- Runoff co-efficient for tiles surface(typical case)=0.85 (Table in Appendix B)
- Co-efficient for evaporation,spillage =0.80
- Annual water harvesting potential=2053*0.611*0.85*0.80=853 m^3
- Volume of water harvested=853000 litres.
- Tank Capacity has to be designed for the dry period i.e., the period between the consecutive rainy seasons. With the rainy season extending over 4 months,dry season is of 245 days.
- Drinking water requirement= 245*10*800 = 1960000 litres,where 10 litre is per capita consumption & 800 is the total strength of school.
- Tank should be 20% larger than required i.e,2352000 litres.(2352 metre cube).
- Most Commonly used material for making tanks are RCC, ferrocement, masonary, plastic or metal(galvanised iron).

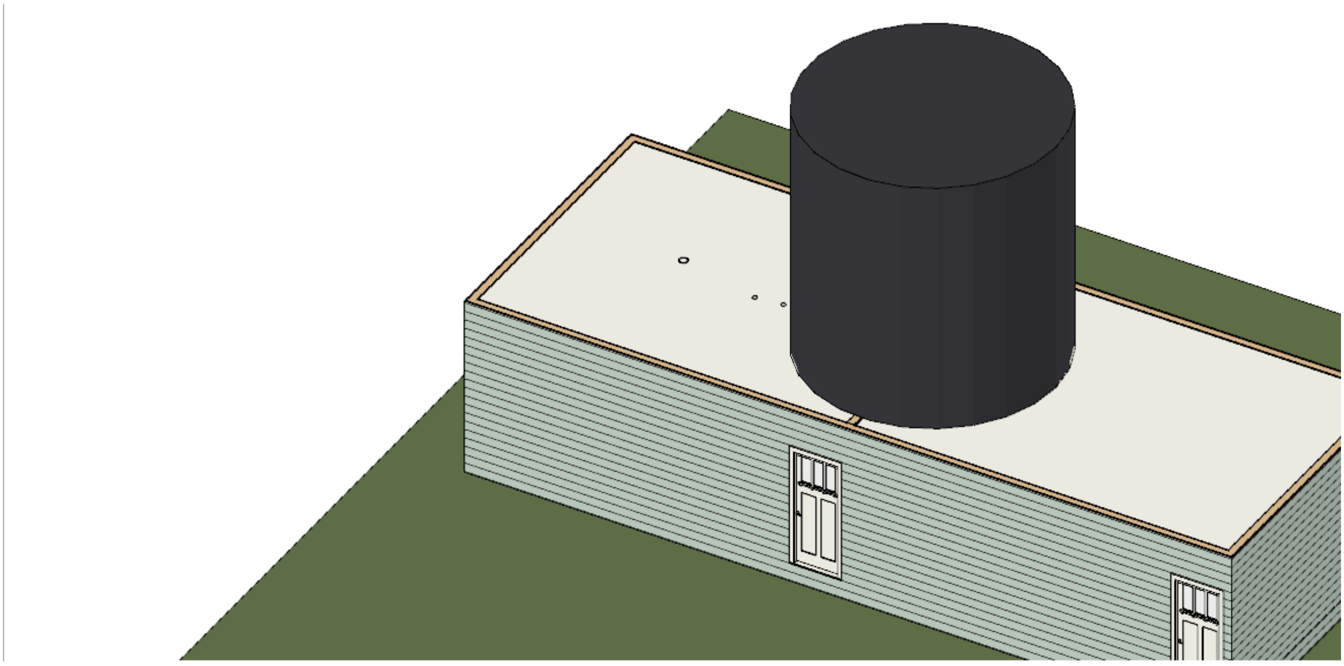

Fig 5.1 Rain Water Tank placed on Rooftop

- Capacity of Tank = 2352 metre cube.
- Radius of Tank = 7.06 metre
- Height of Tank = 15 metre

5.5 SOLAR CELLS/PANELS

- Solar panels mounted on metal structures on the rooftop of the building produce DC electricity when exposed to sunshine, which is then converted to AC for use in schools.

- The System is a hybrid solar system, with two solar panel array of 8KW, and an inverter of 14KW (for backup purpose ,sufficient capacity to handle the entire lighting and fan load of the Secondary Schools).

- We have used lights(80 Watts total),2 fans(120 Watt each) and 50 watt extra for plugging purpose in each classroom. Office, canteen, labs & faculty room average consumption is 1000 Watt.

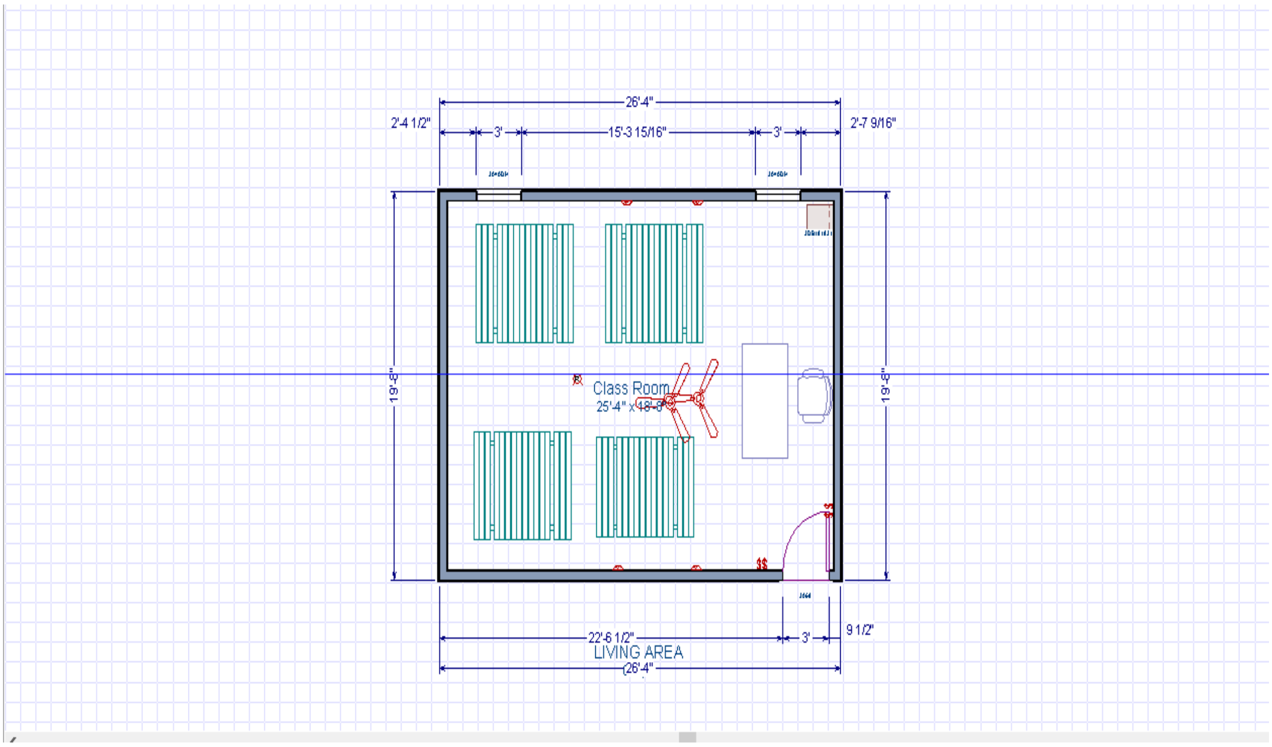

Fig 5.2 2-D view of classroom on Chief Architect

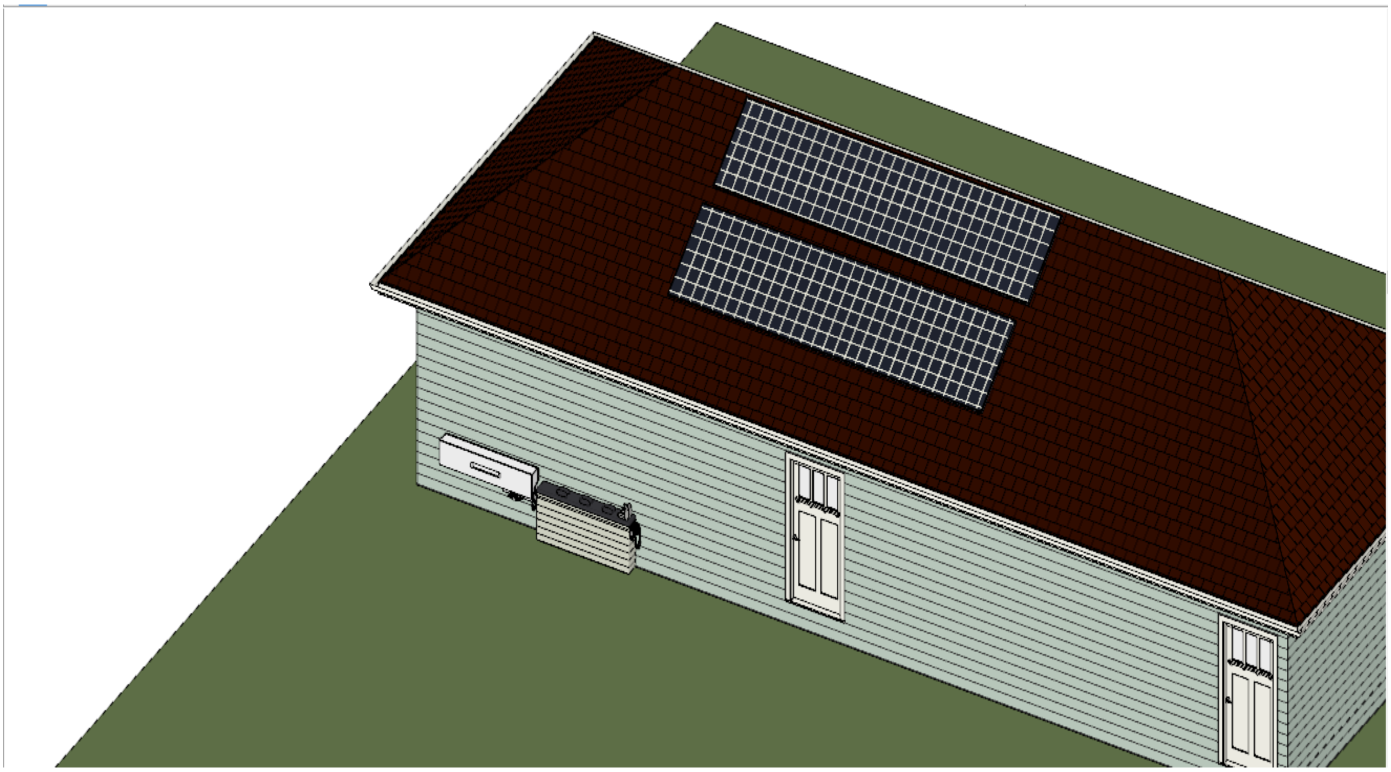

Fig 5.3 Two solar panel array of 8KW, and an inverter of 14KW,a battery on Chief Architect

5.6 Solar Panel as a Power System

- Energy Production by Two solar panel systems in One day =2*(8kW*8Hr)=128kW-hr.
- Power consumed by School(20class rooms+ 600Watt consumption by 10 other rooms)=20*(2*40+2*60+50)+10*(1000)=15kW
- Energy consumption in 8hr (in a working day) is =15*8=120kW-hr

Fig. 5.4 Solar panels placed on roof-top

Orientation of Buillding

The orientation of the school will be towards north direction because the ideal direction to point your Solar Panels in India is North. This is because the sun rises in the East then moves North until mid-day. When it heads west to set. If your roof is NE or NW you will only lose 3% - 4% of your power due to not being directly North.

So, No big deal. If your roof is facing East or West, then you will probably lose 15% - 20% of your power.

5.7 LIGHTING

Lighting systems should provide even and consistent lighting and be augmented with task-specific lighting where needed. A well designed direct ceiling mounted T-8 system with electronic ballasts will generally provide quality lighting levels. However, a direct/indirect T-8 or T-5 system with electronic ballasts can provide even more consistent lighting, with the potential of greater energy savings. Use daylighting – but carefully locate windows and provide shading screens or blinds to avoid glare. Also consider the use of daylight sensors to turn off lights when daylight is sufficient.

In classrooms, T-8 electronic ballast lighting (direct or indirect) systems will provide high quality even illumination with low energy use**.**

For high ceiling areas (e.g. libraries) lamps can be either T-8 (typically for mounting heights up to 25 feet) or newer, even more energy efficient T-5 HO (high output) lamps (up to50 feet).

To take advantage of natural daylight, controls can be used to dim or turn off electric lights in response to levels of natural daylight. There are two types of controls – dimming systems and switching systems.

The switching system is often preferred because of ease of maintenance and installation. The switch system can be achieved using a 3 tube fixture switching between one or two tubes depending on available daylight. Typically at least one photo sensor is required for each building orientation.

Solar Tubes: Solar Tubes are aluminum pipes laminated with a mirrored surface on the inside, designed to bring exterior daylight from the roof to interior spaces without access to daylight. The light is distributed through a diffuser which maximizes daylight distribution into the spaces even on cloudy days.We can set up this tube near solar panel which is exposed to sunlight.

Fig 5.5 Solar Tubes

	CRI (colour rendering index)	**LPW (Lumens/Watt)**
T-8	85	92
T-5	85	103

Both T-8 and T-5 systemss have same CRI value.There is no difference in quality of light between them.T-8 system will have less quantity of light as compared to T-5 due to lesser value of LPW.

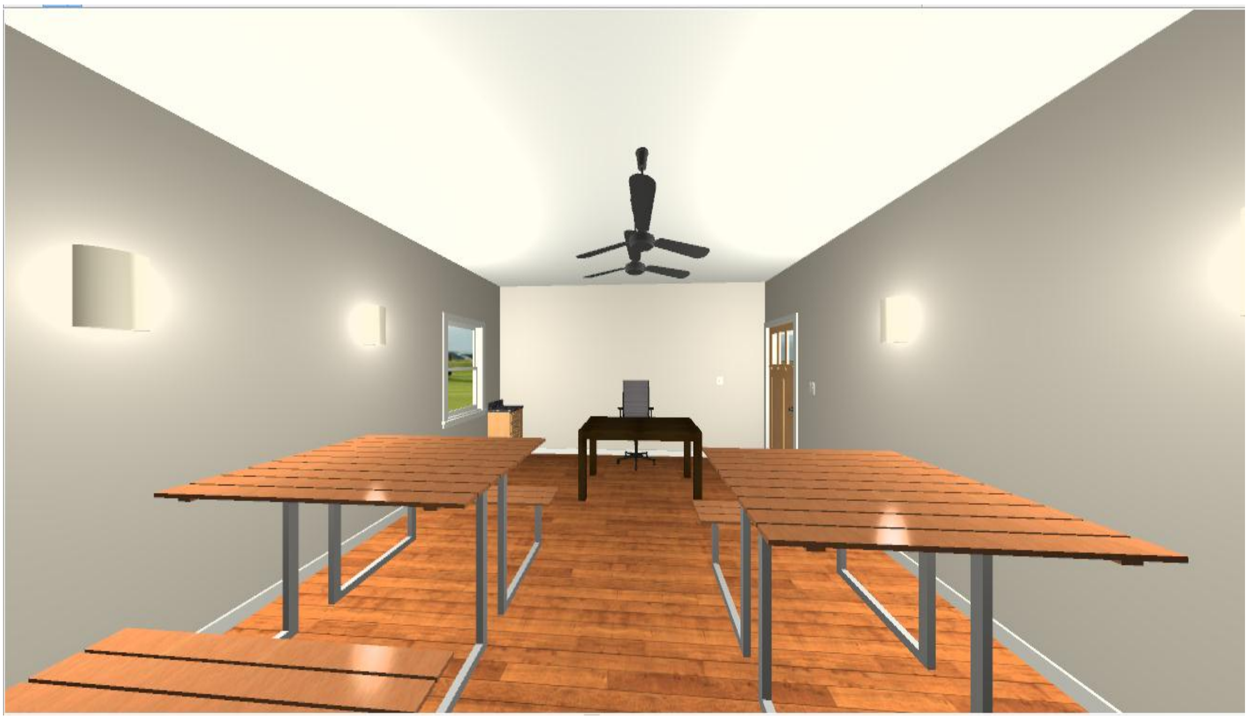

Fig 5.6 T-5 Lightning System in a classroom on Chief Architect

5.8 GLASSES AS A GLAZING

Glass is a uniform material, a solidified liquid. By its property of transparency it opens up our buildings to the outside world. In modern architecture there is tendency to open up our buildings by using very large facades that are as transparent as possible.In the external wall, glass can be used as a curtain wall or structural glazing.

Glass is not essentially transparent. They are available in several opacities and various textures and finishes.

Glass is made from the following raw materials: Sand; soda-ash,limestone,dolomite,feldspar,sodium sulphate. These substances are themselves compounds of various elements and a chemical analysis shows that flat glass is made up from the following materials, used in various proportions:

- Silica (S_2O_2) 71.0 to 78.0%
- Alumina (Al_2O_3) 0.5 to 1.5%
- Iron oxide (Fe_20_3) 0.05 to 0.15%
- Calcium oxide (CaO) 5.0 to 10.0%
- Magnesium oxide (MgO) 2.0 to 5.0%
- Sodium oxide (Na_2O) 13.0 to 16.0%
- Potassium oxide (K_2O) 0.0 to 1.0%
- Sulphur trioxide (SO_3) 0.0 to 0.5%

1. Float Glass

- Most widely used type of glass
- Monolithic and highly transparent
- Produced by flowing molten glass over a bath of molten tin and slowly cooling .
- Has uniform thickness, flatness ,excellent optical quality.

- Manufactured in two main varieties, i.e.; clear and tinted.
- We have used it as mirror glasses in washrooms. Float glass can be toughened, a process that creates safety glass out of annealed glass.
- Available in thicknesses 2-19 mm
- Can be coloured during manufacturing.

Fig 5.7 Float Glass Used As mirrors in washrooms

2. Sheet Glass

- Actual color green (or sometimes blue).

- Sizes available:

  2mm, 3mm, 4mm, 5mm,6mm, 8mm, 10mm, 12mm, 15mm and 19mm.
- We have used it in a large sized doors in washrooms and classrooms.

Thickness	Cost
4-6 mm	Rs 53/sq.m
8-12 mm	Rs 63/sq.m

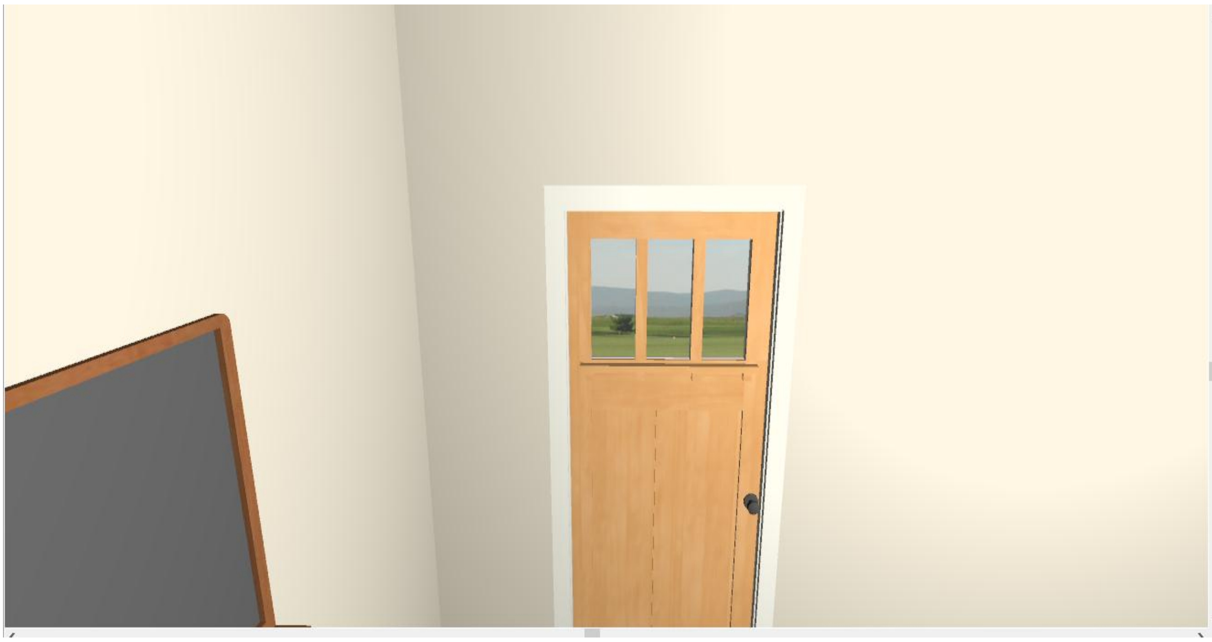

Fig 5.8 Sheet glasses used In large size doors in washroom

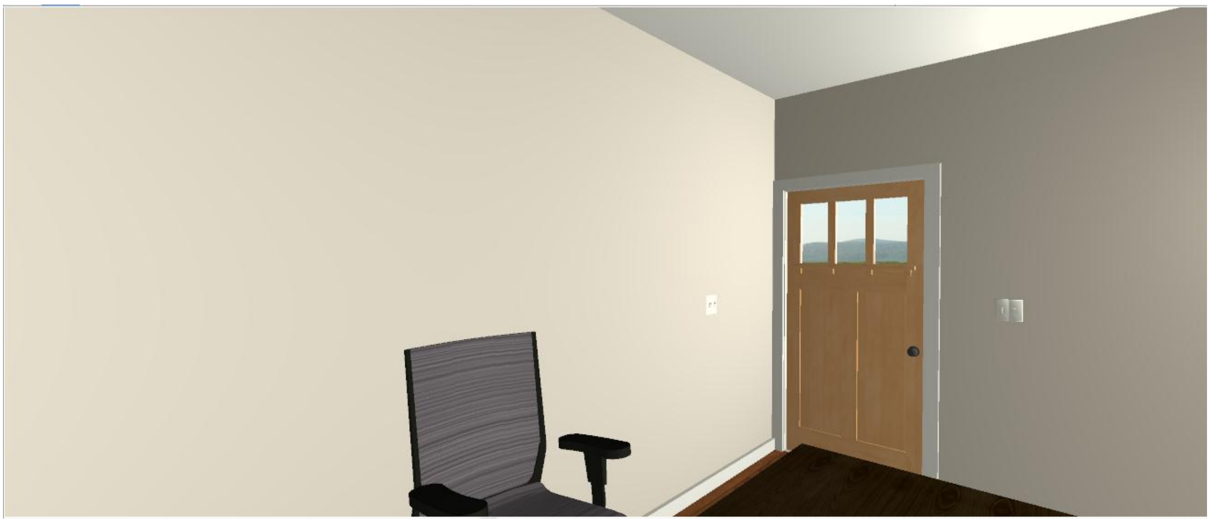

Fig 5.9 Sheet glasses used in doors in classroom

3. Patterned Glass

- Sometimes referred to as "figured" or "rolled"glass.
- Has a pattern or texture impressed on one or both sides in the process of rolling.
- This glass surface has a patterned decorative design which provide translucency and some degrees of obscurity.
- Patterns are classified as decorative or glazing i.e., used primarily for their functional properties.
- Used on a table top and shelf in classrooms.
- Is difficult to clean as dust settles between the crevices
- Thickness: 4mm, 6mm.
- Sizes: 2140 x 1280 mm, 2140 x 1320 mm respectively.

Fig 5.10 Patterened Glasses

Fig5.11 Patterned Glasses used on table and Shelf in classroom

4. Tinted Glass

- Manufactured by adding a dye at the molten glass stage
- Used to minimize solar heat gain and glare while it also absorbs heat.
- Used in Classrooms and washrooms.
- Available in grey, bronze, green, blue and blue/green
- Allows for increased control of comfort and energy usage

Sizes available:

- Grey and Bronze - 4mm, 5mm, 6mm,8mm,and 10mm
- Blue - 6mm
- Green - 5mm,6mm,&10mm
- Blue/Green - 6mm and 10mm

Fig 5.12 Tinted glass used as washroom window glass & float glasses in mirrors

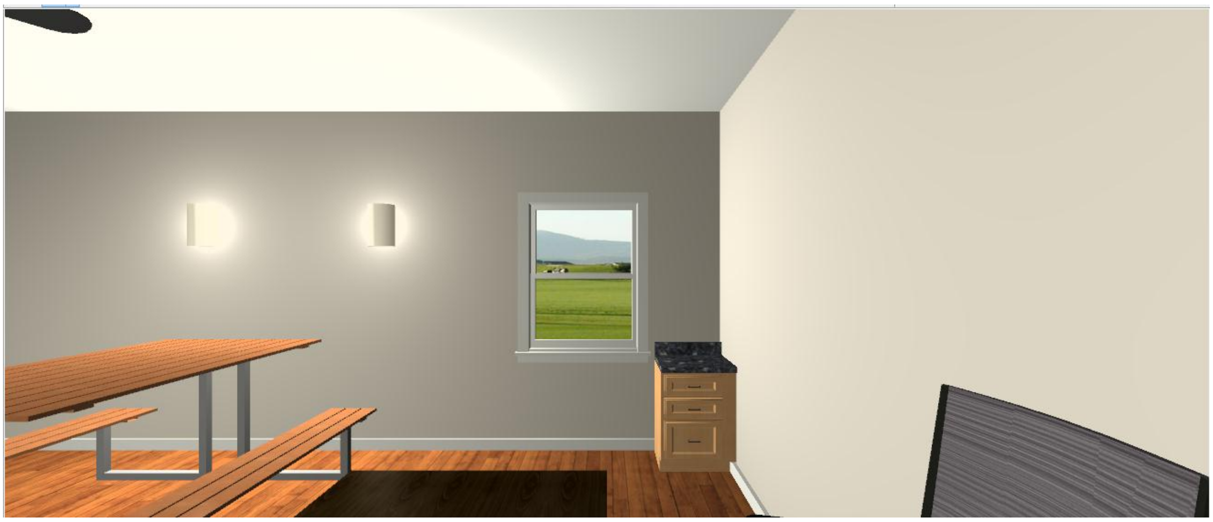

Fig 5.13 Tinted glass used in windows in classroom

Thickness(mm)	Rate/sq ft (Rs.)
3	**22**
4	**30**
5	**35**
6	**38**
8	**70**
10	**90**

5.9 Miscellaneous

Building Insulation: Building insulation means creating a resistance to the flow of heat from the warmer side to the colder side of the insulated building roof or walls. This is achieved by adding a layer of thermal insulating material like EPS(expanded polystyrene) to the building element. This improves the comfort level and also reduces electrical power consumption in air conditioning / cooling very substantially.

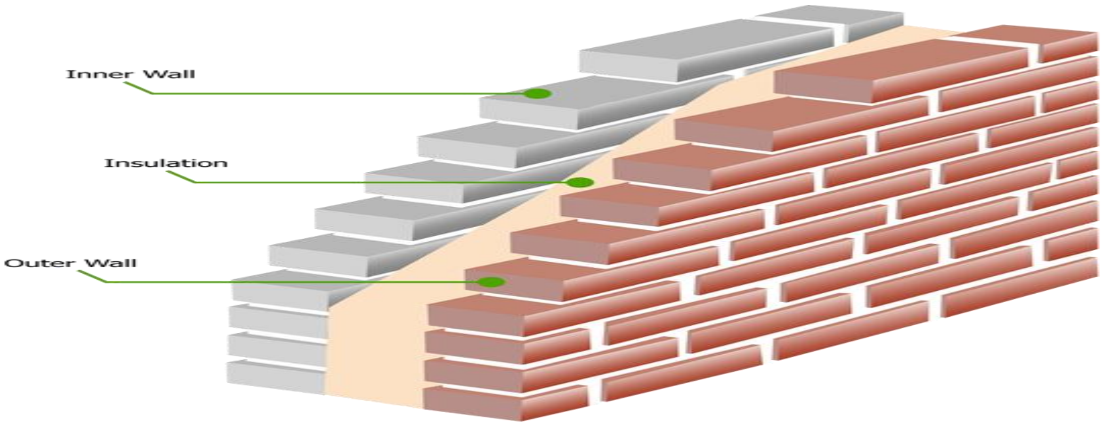

Fig 5.14 Building Insulation

Benefits:

- Minimizes heat loss from the interior in winter months.
- Minimizes heat gain from outside in the summer months.
- Reduce air conditioning requirements thus lowering the capacity (tonnage) of airconditioner required as well as the operating power and maintenance costs.

5.10 HVAC (Heating, Ventilation & Air Conditioning)

Designers should consider the use of natural ventilation and operable windows to supplement mechanical ventilation.

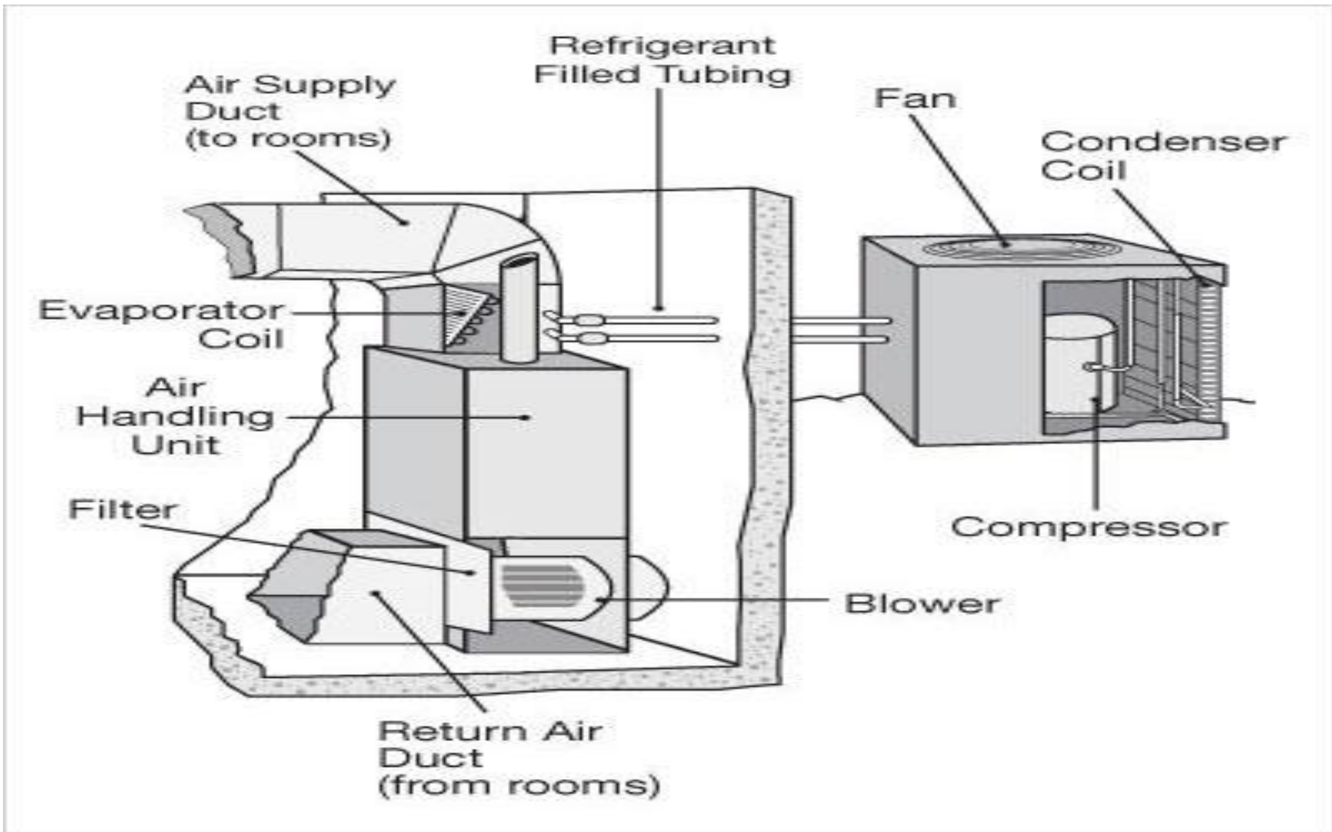

Fig 5.15 Components of HVAC System

Working:

Central air conditioning units are set up for large spaces which controls the temperature & quality of air inside occupied spaces.They consist of duct networks (inlet & exhaust) & air handling unit.Fresh cold air is brought to the rooms from Air Handling unit.Air enters the room through diffusers which control the spread of air in the occupied space.Incoming air with controlled temperature & flow rate gets mixed with air inside room to achieve the desired thermal comfort.This circulated air is then taken back to the air handling unit by Return Air Duct.Return Air is partially exhausted & rest is sent to air handling unit where it is cooled down before sending it back to the building .AHU consist of following components:

1) Fan, which pushes the exhaust air back in the inlet duct network.

2) Air filter which cleans the exhaust air.

3) Compressor & coil assembly: Compressor compreeses the coolant present in the coils to a high pressure. Coolant is then released through a relief valve in the coils & due to sudden expansion, temperature inside the coils falls significantly. Clean and warm exhaust air coming through filter strikes the outer walls of the low temperature coils and gets cooled down. The air is then sent back to the inlet duct network by fan.

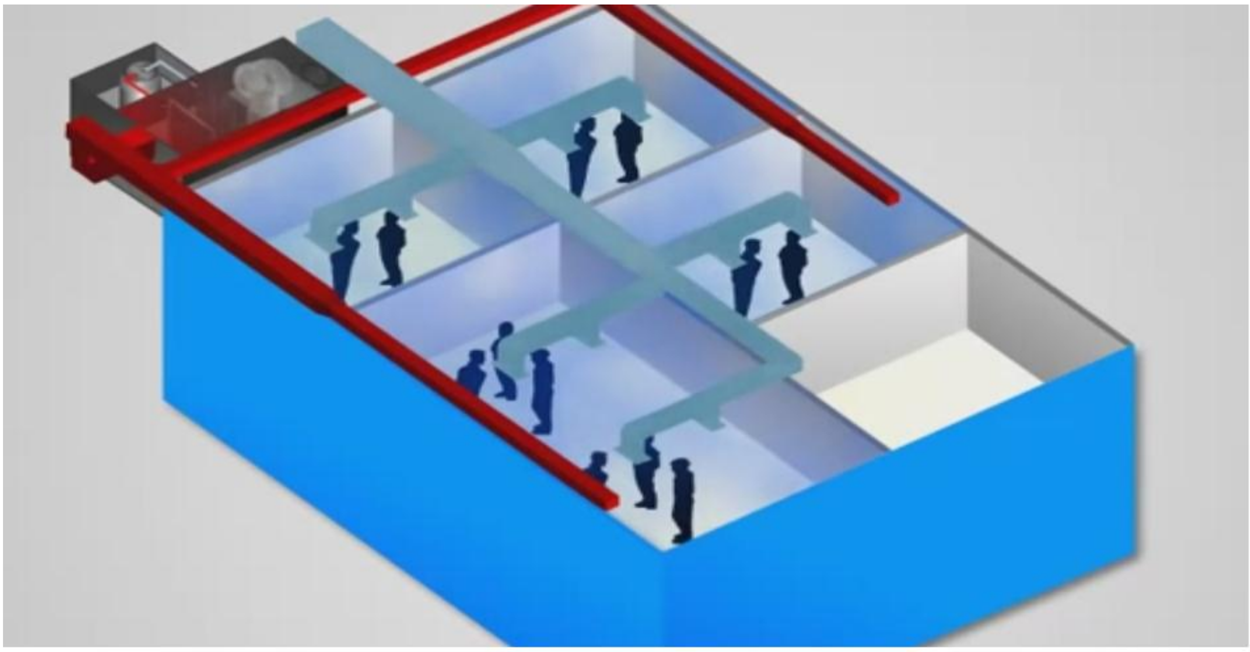

Fig 5.16 HVAC system setup in admin office

5.11 Green Belts:

We have provided green belt covering near the boundary of school.

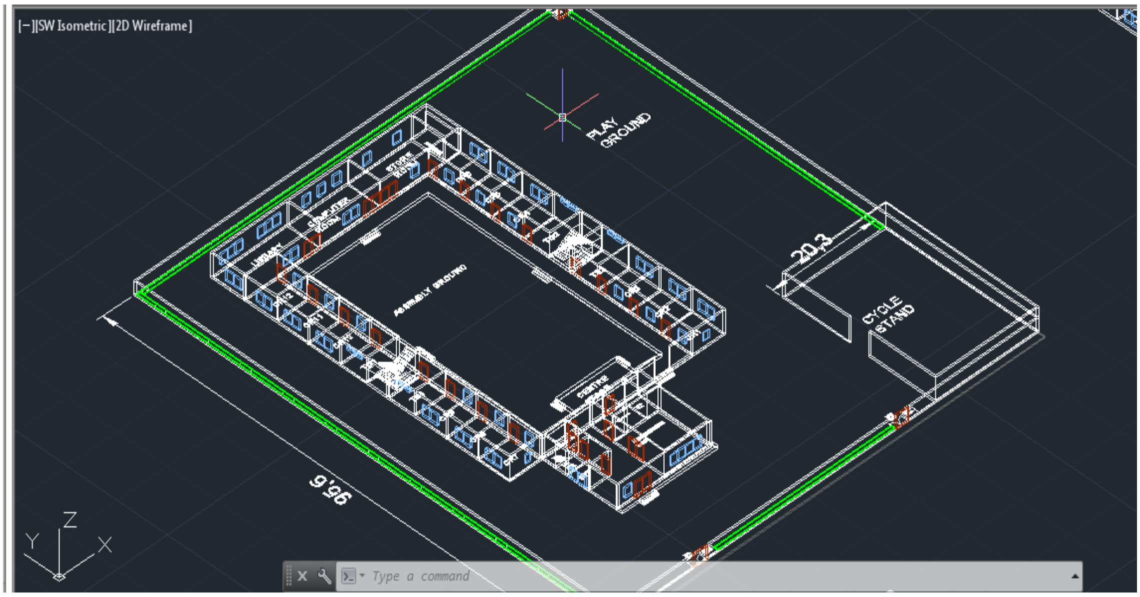

Fig 5.17 Green lines showing green belts

CONCLUSION

A “green school” is an energy efficient, higher performing school that can be environmentally Beneficial , economical to build and operate, and offer improved learning environments. It is all about protecting the environment, lowering operating costs, improving the health and quality of the learning environment, and integrating learning opportunities with the built environment. Green school should be energy efficient ,financial sustainable, demonstrate environment sustainability, support students’ achievement. With a definition of “green” and draft green objectives in place, the next task is to set a whole life budget. Budgets should consider costs over the entire life of the building. A board that saves on construction costs, only to incur higher long term operation and maintenance costs, has not realized any savings at all.

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We have designed rain water harvesting tank by taking the strength of school into consideration. We have mounted two solar panels on the roof top for backup purpose sufficient capacity to handle the entire lighting and fan load of the Secondary School. Further we have used some other energy efficient technologies like Solar Tube, Building Insulation, Kooltiles & HVAC system. Additionaly ,we have used different types of glazing glasses for various purposes.

The School we have designed has area of 2 acre with 20 Classrooms and various other types of Spaces fulfilling the requirements of an ideal school according to the Central Board of Secondary Education. The Structural Cost estimated of the comes out nearly Rs 90 Lacs.

APPENDIX A:

Table No. 1—Rainfall Data for Major Cities

[Source Climatological tables of observations in India (1951-1980) by Indian Metrological Department].

S. No.	City	Annual rain fall (mm)(R)	S.No.	City	Annual rain fall (mm)(R)
	A-1 Class				
1	Mumbai	2146.6	38	Solapur	750.8
2	New Delhi (Safdarjung)	797.3	39	Thiruvananthapuram	1827.7
3	New Delhi (Palam)	794.0	40	Tiruchirappali	880.2
	A-Class				
4	Ahmedabad	803.4	41	Varanasi	1025.4
5	Bangalore	970.0	42	Vishakhapatnam	968.8
	C-Class				
6	Calcutta	1641.4	43	Portblair	3168.8
7	Chennai	1333.8	44	Dibrugarh	2588.7
8	Hyderabad	812.5	45	Tezpur	1768.3
	B-1 Class				
9	Bhopal	1146.7	46	Chapra	1028.3
10	Indore	1008.3	47	Jamshedpur	1320.7
11	Jaipur	673.9	48	Muzaffarpur	1239.8
12	Kanpur	832.6	49	Bhuj	413.6
13	Lucknow	1021.5	50	Karnal	814.1
14	Ludhiana	752.3	51	Simla	1424.8
15	Nagpur	1112.7	52	Bidar	981.1
16	Pine	721.7	53	Hoshangabad	1225.9
17	Surat	1209.4	54	Ratlam	1033.5
	B-2 Class				
18	Agra	776.5	55	Ujjain	934.1
19	Allahabad	1017.7	56	Kolhapur	1138.5
20	Amritsar	681.2	57	Imphal	1353.1
21	Aurangabad	688.05	58	Shillong	2050.5
22	Bareli	1071.9	59	Kohima	1856.0
23	Chandigarh	1059.3	60	Bhubaneshwar	1542.2
24	Coimbatore	631.0	61	Cuttack	1475.3
25	Gorakhpur	1228.1	62	Pathankot	1319.0
26	Guwahati	1717.7	63	Alwar	774.6
27	Gwalior	899.0	64	Vellure	1004.4
28	Jabalpur	1331.6	65	Agartala	2178.6
29	Kochi	3228.3	66	Aligarh	781.6
30	Kota	761.4	67	Dehradun	2315.4
31	Madurai	873.3	68	Roorkee	1156.4
32	Meerut	901.0	69	Darjiling	2667.1
33	Nasik	703.0			
34	Patna	1003.4			
35	Rajkot	726.9			
36	Ranchi	1431.6			
37	Salem	1014.0			

APPENDIX B:

RUNOFF CO-EFFICIENT OF VARIOUS SURFACES

1.	**Roof Catchment**	**Co-efficient**
1.1	Tiles	0.8-0.9
1.2	Corrugated metal sheets	0.7-0.9
2.	**Ground Surface Covering**	
2.1	Untreated Ground Catchments	
2.1.1	Soil on slope less than 10%	0.0-0.3
2.1.2	Rocky material catchment	0.2-0.5
2.1.3	Business Area	
2.1.3.1	Down town	0.70- 0.95
2.1.3.2	Neighbourhood	0.50 - 0.70
2.2	Residential Complexes in Urban Areas	
2.2.1	Single family	0.30 - 0.50
2.2.2	Multiunits,detached	0.40 - 0.60
2.2.3	Multiunits, attached	0.60 - 0.75
2.3	Residential Complexes in Suburban Areas Apartments	0.50 - 0.70
2.4	Industrial	
2.4.1	Light	0.50 - 0.70
2.4.2	Heavy	0.60 - 0.90
2.5	Parks, cemeteries	0.10 - 0.25
2.6	Play grounds	0.20 - 0.35
2.7	Railroad yard	0.20 - 0.35
2.8.	Unimproved Land Areas	0.10 - 0.30
2.9	Aspheltic or concrete pavement	0.70 - 0.95
2.10	Brick pavement	0.70 - 0.85
2.11	Lawns, sandy soil having slopes	
2.11.1	Flat 2%	0.05 - 0.10
2.11.2	Average 2 to7%	0.10 - 0.15

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