DEVELOPMENT OF STATE-SPECIFIC GUIDELINES AND MODEL DESIGN FOR SCHOOLS

FINAL REPORT

Submitted to

Office of the State Project Director (SSA/RMSA)

Himachal Pradesh School Education Society, Shimla

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
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PROJECT INVESTIGATOR'S DECLARATION

I hereby certify that the work being presented in the Research Project entitled **"Development of State-specific guidelines and Model Design for Schools"** is work carried out during the period from November 2013 to March 2015. This project was sponsored by SSA/RMSA Shimla, Himachal Pradesh.

Project Investigator
Department of Civil Engineering

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I am especially thankful to the following students/associates who have been attached with me for the specific work.

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Finally I am thankful to Department of Civil Engineering and National Institute of Technology Hamirpur for giving me the approval to work with office of the State Project Director (SSA/RMSA), Himachal Pradesh School Education Society, Shimla.

Dr. Hemant Kumar Vinayak

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1. Introduction

Education is the main pillar on which any development exists. It is important for any nation to enhance education and create an environment for better learning that will help the nation to grow. The schools as a building are exposed to natural hazards such as earthquakes, wildfires, floods, cyclones, landslides. Non-disaster resilient schools not only cause the casualties of student in the form of injuries or death but also damage the school building and this damage to physical infrastructure is a great economic loss for the country. The cost of reconstruction becomes a burden on the economy of the state. Apart from saving students' lives, sustaining economies and minimizing harm to teachers and school personnel is also an important requirement. Whenever these hazards occur they impact human settlement and cause a loss of student's life and property loss as shown in Table 1.

Table 1 Hazards and damage

Hazard	Year	Place	Destruction
Land slide	2014	Jakarta	Landslides have damaged 19 houses and two school buildings in Lebak District, Banten Province
Earthquake	2008	Sichuan	Killed more than 7000 children and estimated 7000 classrooms were destroyed
Cyclone	2007	Bangladesh	Destroyed 496 school buildings and damaged 2000 and more.
Super typhoon	2006	Philippines	Caused approx. $20m USD damage to schools
Earthquake	2005	Pakistan	Killed at least 17000 students and injured another 50000 and about 10000 schools were destroyed;
Earthquake	2001	Gujarat	The quake destroyed around 40% of homes, 8 schools, and 2 hospitals in Bhuj.
Fire	2002	Saudi Arabia	15 young school girls died.

Apart from these natural hazards, problems related to functional requirements such as acoustics, illumination, stampede, space allocation, ventilation etc. also affect the learning process.

- Acoustics which is the main component of learning in school as most of the interaction between the student and teacher is in terms of verbal information and hence classrooms should be acoustically sound.
- Another important component is the illumination of the classroom, if the illumination of the classroom is not up to the standards it creates problems in reading the text-books and performing other activities like experiments in labs, arts or cultural programs.
- Problem related to stampede which specifically derives the need of proper design and location of stairs in a school building.

Moreover, the other problems like circulation area, space allocation and miscellaneous including access approach to school, components related to physically retard students, rain water harvesting also plays a vital role in the construction of safer model school buildings as shown in Table 2.

Table 2 Functions and related problems

Function	Problem
Acoustics	Less speech intelligibility due to poor acoustic design
Illumination	Poor day-lighting in classrooms. Lack of artificial illumination in case of weather change
Stampede	Stairs are in open and not met with the standards
Fire	Proper exits are not provided as per standard norms
Miscellaneous	Inaccessibility for physically retards and no provision for rain water harvesting.
Non- structural members	Improper anchorage of non- structural members

Hence the approach to develop model school construction guidelines provides understanding and skills to construct a disaster-resilient and functionally efficient school building Such Schools which are constructed in a standard manner with the help of the guidelines becomes a hub of learning place for an entire community and therefore should be construct

2. Objective and Scope

The need of guiding principles for the construction of model schools has been identified by government and school communities as a critical need for reducing, and ideally preventing, the ruining consequences of countless hazard events. Although there are many governments and private organizations engaged in the construction and repair of model schools as well as the production of knowledge based on experience and research, there is presently no one reference point from which to easily navigate and obtain the appropriate technical knowledge and valuable insights gained from similar initiatives around the country. Therefore, the development and utilization of this Technical Guidance Notes on model School Construction, which articulate a series of recommendations and guide readers to more technical and context-specific information, is an important step in a global effort to ensure that schools in hazard-prone regions are designed and built to best protect their inhabitants and also work efficiently on the basis of functional and constructional requirements needed for the school buildings. The guidelines are framed in a manner that the proposed design with the use of these guidelines is a well occupied and efficient building which can minimize the disaster relevant and most importantly the constructional restrained.

Before forming the guidelines a rapid visual survey of school buildings was done to visualize and understand the current norms of construction practices and the common problems in the school buildings. The study area for such guidelines is taken as district Hamirpur, Himachal Pradesh. The two key objectives of the sample checking exercise were:

1. To screen the existing school buildings with the aid of Rapid Visual Survey format for Schools.
2. To identify the gaps/weaknesses and suggest appropriate remedial measures.

By this exercise of sample checking the problems related to school buildings are highlighted and thus suggestions are given as per the standards so that we can achieve the target to construct a model school building which provides the safer and efficient environment for the learning process.

Scope: This study would include the development of model school design considering the following aspects:

Natural: Earthquakes, Wind storms, Floods, Landslides, Wildfires, Stampede, Road accidents, etc.

Functional: Illumination in room, Ventilation, Acoustics, Space allocation, Stairways, Doors and windows and miscellaneous.

3. Methodology

The codal provisions that guide the construction of various structural and non-structural elements have been framed independently and sometimes contradict to each other. Hence there should be a single reference which eliminate this contradiction and serve as a single reference for all issues related to school buildings. The model design will be developed for the building with various room sizes as per requirement for non-engineered masonary construction and engineered construction. The model design will be based on the comparison of the existing classrooms with the RMSA classroom design 2013.

The problems related with the existing classrooms can be marked with the help of rapid visual surveys which gives an idea in concern to the model and RMSA designs. The rapid visual survey has been done on the following basis:

3.1 *Sample selection*

The samples are taken on a random basis in district Hamirpur as 10% of the total number of schools as listed in the document district and constituency wise institution in HP. The samples varied on the basis of classification of schools that is primary, higher secondary or senior secondary.

3.2 *Instrument used*

A format is prepared on the basis of IS codal provisions and with the reference of existing RVS formats as given by BIS, NDMA, NIDM, IIT Roorkee, NIT Hamirpur to check the current condition of the schools as per format. Apart from the rapid visual survey format for school buildings instrument used are lux meter to measure the intensity of light in lux, sound meter to measure the noise level (acoustics purpose) and camera to capture the problems in the form of photographs.

3.3 *Data collection*

Visits were made to each of the selected schools. The information was collected by filling rapid visual survey format for school buildings and photographs taken. The data collection process was closely supervised, monitored and coordinated.

4. Format of study

The format of the study is presented in this section with the explanation. In this section the normal text part is of the rapid visual survey format for school building while text in brackets in italic style is the explanation of that part.

Rapid Visual Survey Format for School Building

1.0 Basic Aspects

Building name and address ……

Classification of school PS / HS / SSS Total covered area (m^2)……

Number of stories and year built ……

(Fill the name and address of the school building. Classify the school as primary, higher secondary, and senior secondary. Calculate the total covered area in square meter. Mention the number of stories and year built of the building to be screened.)

2.0 Plan Sketch

(Sketch the plan of the building by clearly mentioning the place and size of opening along with the size of the room.)

3.0 Building Topology

3.1 Check for seismic provisions

Whether wall length/thickness ratio < 35 or wall length > 8 m.

(Measure the wall length and calculate the wall length/thickness ratio)

Fig. 1 Poor design-wall length > 8m (GSSSl Nalti)

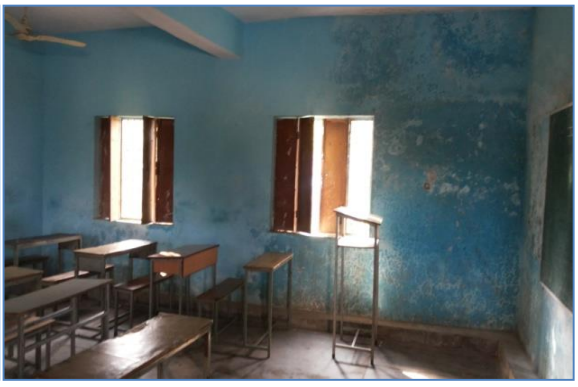


Fig. 2 Better design-wall length <8m (GSSS Chabutra)

Plinth band yes / no Window sill band yes / no Roof band yes / no

(Check for various bands viz. plinth band, window sill band, and roof band.)

Fig. 3 roof band

Fig. 4 plinth band and roof band

Severe vertical irregularities yes / no Severe plan irregularities yes / no

(Check for vertical/plan irregularities.)

Fig.5 Vertical irregularity

Fig.6 Mass irregularity

Vertical reinforcement at corners / junctions Height of the storey ……

(Check for the vertical reinforcement. Measure the height of the storey in meters.)

Percentage of opening ……. Location of opening ok/ not ok

(Calculate the percentage of opening and it must be less than 20 %.)

3.2 Check for landslide

Landslide prone site yes / no Retaining wall yes / no

(If any of the situations occurs then mark yes

- *Sticking doors & windows, and visible open spaces indicating jambs and frames out of plumb*
- *New cracks and scarps or unusual bulges in the ground, roads or pavements*
- *Soil moving away from foundation*
- *Broken water lines and other underground utilities*
- *Leaning telephone poles, trees, retaining walls or fences and damage to building elements*

- Check for the retaining wall)

3.3 Check for wind load

Type of the roof …… Standards met with minimizing the wind load ok / not ok

(M*ention the type of roof present viz. flat slab, gable, etc.)*

Fig. 7Gable type

Fig. 8 flat roof

3.4 Fire Requirement Size of the exit ok / not ok

(- Minimum width 100 cm and height 200 cm as per clause 14.4.1.2 of IS 8827-1978
- Maximum travel distance should be 22.5m as per table 3 and clause 3.6.1 of IS 1644-2013)

4.0 Constructional Requirements

4.1 Space Allocation

Area of the classroom: Pre-school……m^2 Primary / junior……m^2 Secondary …… m^2

(Area of classroom: calculate the area of the classroom in square meters. Usable floor area as per Cl 4.3 IS 8827-1983 as shown in Table 3

Table 3 Usable floor area

SL No.	CATEGORY	No. of student places per classroom	Gross area of classroom in m^2 per student place min
1.	Pre-school	20/25	2.00
2.	Primary/junior		
	With furniture	40	1.11
	With squatting	40	0.74
3.	Secondary/ Higher secondary	40	1.26

Aspect ratio ok / not ok Circulation area ok / not ok

(- Aspect ratio: clause 4.5.2 of IS 8827-1978 the proportion of length to breadth should not exceeds 1.5:1.
- Circulation area: should not be more than 24 and 18% respectively for single loaded and double loaded as per clause 9.1 of IS 8827-1978)

4.2 Size of Opening

Location of opening in one wall / in both walls Total Size of openings ok / not ok

(- Check the location of openings in walls. - Total Size of openings < 20 %.)

4.3 Stairways Tread ok/not ok Riser ok/not ok Handrail ok/not ok

Number of risers in one flight …… Width of the staircase ok / not ok

(- As per IS 8827-1978 cl. 14.4.2.5 min. tread 30 cm, cl. 14.4.2.6,max. riser 15 cm,
- As per cl. 3.10.6 IS 1644:2013 Minimum width of staircase should be 1.5 meters.
As per cl. 3.10.9 IS 1644:2013 handrail shall be with a min. height of 100 cm., number of risers in one flight must be limited to 12.)

5.0 Functional Requirements

Height of window sill …… mm

(Calculate the window sill height in mm. As per clause 4.5.3 IS 8827-1978 max. value allowed 600 and 800mm for rooms with furniture and squatting respectively.)

Illumination at worst …… lux Illumination at best …… lux

(Measure the intensity of light in lux with the aid of luxmeter. The necessary illumination levels for various visual tasks related to school are given in table 5 of IS 8827-1978)

Table 4 Illumination level for various visual tasks for school buildings

Sl. no.	Visual task	Illumination level (lux)
1.	Classroom desk top, chalkboards	150-300
2.	Laboratories/workshops	200-300
3.	Library-reading tables	150-300
4.	Drawing, typing	300
5.	Toilets	150
6.	Manual training	150

Noise level…….. dB Height of the furniture …… cm

(- Noise level should be checked with sound meter and it should have maximum value of 40dB as per clause 6.2 of IS 8827-1978.
- Measure the dimensions of the class-room furniture and write down accordingly.)

Type of doors and windows steel / timber / other material

(Analyze the material used in doors and windows and mark accordingly)

Danger of stampede yes / no Road setback ok / not ok

(- Danger of stampede should be there in case of slippery floors and water seepage.
- Measure the setback distance of the building from main road and it should be less than 15 meters in case of ok.)

Provision for rain water harvesting yes / no

(Check whether retaining wall is present or not)

6.0 Non-Structural Components

Table 5 Rapid visual survey format Non –structural components for school buildings

Potential hazard	Does the item is anchored?	Potential hazard	Does the item is anchored?
Black/green boards		Laboratory equipment	
Bookshelves		Coolers	
Computer equipment		Water tank	
Ceiling fan		Almirah	
Fire extinguisher		Flower pots on chajja or at height	
Kitchen equipment			

(Check the hazard in case it needs to be anchored or fixed)

7.0 Remarks *Additional information or suggestions if any.*

5. Observations and Findings

On the basis of the collected data and with the help of photographs the defects/shortcomings are marked and thus pointing out the aspects for detailed study. It is found that the pattern of schools structures in the sample survey is same apart from some of the exceptions. The general building plan is that the classrooms are accompanied by veranda for circulation. It is observed that general practices of construction after year 2000 are generally RCC frame structure. The traditional plan of construction involved shortcomings and the structural elements are not as per the provisions with the standard codes. Such as, stairways are constructed in open area without any shelter, the circulation area are higher than the provided standards, vertical or plan irregularities, the size of exit is not appropriate and many more. Apart from constructional defects, defects in the functional components of school are present too eg. Problems with acoustics, illumination and many more. The common visual shortcomings are shown in the form of photographs in the proceeding section.

- In some schools the vertical, plan as well as mass irregularities are found. These irregularities are the main cause of destruction during natural hazards.

Fig.9 Mass irregularity(GSSS Chabutra)

Fig.10 Chaotic construction (GSSS kot)

- In some places it is founded that the location of the openings are not as per standards IS 4326:1993.

Fig.11 Irregular plan(GSSS kot)

Fig.12 Vertical and plan irregularity(GSSS Tal)

Fig.13 Irregular plan (GSSS Nalti)

Fig.14 Incorrect ventilator placement (GSSS Tal)

Fig.15 Inapropriate construction practice boundry wall acting as retaining wall

Fig.16 inappropriate distance between cut slope and building wall (GPS Panyala)

Fig. 17 Irregular wall pattern responsible for Increased wind speeds. (GSSS Tal)

- Most of the sizes of exits are inappropriate as they do not meet the criteria of min. width 100 cms and height 200 cms.

Fig.18 Size not met with standards(GSSS Kot)

Fig.19 Good example of exit (GSSS Nalti)

- In some of the cases the length to breadth maximum ratio surpassed and hence the size of the classroom are not in accordance with the space allocation as Indian Standards. Apart from the aspect ratio it is found that in most of the schools the circulation area i.e. corridors exceeded the limit provided by the standards.

(a) (b)

Fig.20 (a) and (b) are example of incorrect aspect ratio design(GHS kot)

Fig.21 Corridor area limit exceeded (GSSS Bhota)

Fig.22 Good design example of providing (GSSS Chabutra)

Fig.23 Wrong placement of greenboard causing glare.(GHS Bralhari)

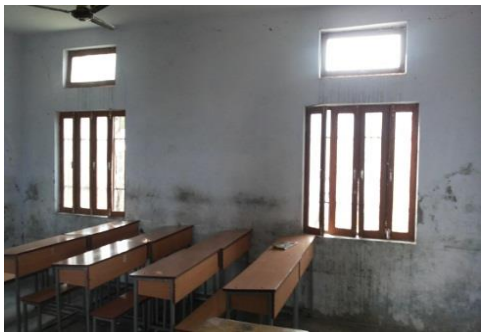


Fig.24 Good example of glazed glass windows and ventilator.(GSSS Tal)

- Most common problem founded with the schools is the problem of stampede due to the stairs. The staircases are constructed in open area which make them inconvenient to use during raining season. The size of stairs, width of staircase, height of handrail was not as per the standards.

Fig.25 Open stairs not as per standards (GPS Pananyala)

Fig.26 Number of stairs present exceeds max. limt per flight.(GSSS Chabutra)

Fig.27 Handrail not installed.(GSSS Bhota)

Fig.28 Improper finishing of handrail (GSSS Tal)

Fig.29 Inappropriate artificial illumination (GPS Dundana)

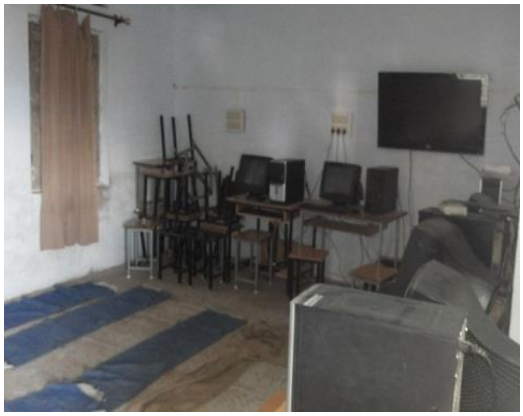
Fig.30 luxmeter indiating 90 lux an insufficient illumation(GSSS Kot)

Fig.31 Steel windows inappropritate for illumination Requirement (GPS Panyala)

❖ The non structural components should be checked for adequate fixtures and anchorage.

(a)

(b)



(c)

(d)

Fig.32 (a) improper placement of bookshelves makes it difficult to operate (GSSS Chabutra) (b) Unanchored Almirah (GPS Panyala) (c) Unanchored computer equipments (GSSS kot) (d) Unanchored Almirah placed in classroom (GSSS kot)

Fig.33 Incorrect setup of rain water harvesting plant (GSSS Nalti)

Miscellaneous:

(a)

(b)

(c)

Fig.34 (a) Unhygienic provision for drinking water (govt school Panyala) (b) Inaccessible approach to school (govt school Panyala) (c) Toilets are inaccessible to physically retards (GSSS Tal)

6. Format taken up for the study

Rapid Visual Survey Format for School Building

1.0 Basic Aspects

Building name and address ……

Classification of school PS / HS / SSS Total covered area (m^2) ……

Number of stories and year built ……

2.0 Plan Sketch

3.0 Building Topology

3.1 Check for seismic provisions:

Whether wall length/thickness ratio < 35 or wall length > 8 m.

Plinth band yes / no Window sill band yes / no Roof band yes/no

Severe vertical irregularities yes / no Severe plan irregularities yes / no

Vertical reinforcement at corners / junctions Height of the storey ……

Percentage of opening ……. Location of opening ok/ not ok

3.2 Landslide prone site yes / no Retaining wall yes / no

3.3 Type of the roof …… Standards met with minimizing the wind load ok / not ok

3.4 Fire Requirement Size of the exit ok / not ok

4.0 Constructional Requirements

4.1 Space Allocation

Area of the classroom: Pre-school……m^2 Primary / junior……m^2 Secondary ……

Aspect ratio ok / not ok Circulation area ok / not ok

4.2 Size of Opening

Location of opening in one wall / in both walls Total Size of openings ok / not ok

4.3 Stairways Tread ok/not ok Riser ok/not ok Handrail ok/not ok

Number of risers in one flight …… Width of the staircase ok / not ok

5.0 Functional Requirements

Height of window sill ……..mm

Illumination at worst …… lux Illumination at best …… lux

Noise level…….. dB Height of the furniture …… cm

Type of doors and windows steel / timber / other material

Danger of stampede yes / no Road setback ok / not ok

Provision for rain water harvesting yes / no

6.0 Non-Structural Components

Potential hazard	**Does the item is anchored?**	**Potential hazard**	**Does the item is anchored?**
Black/green boards		Laboratory equipment	
Bookshelves		Coolers	
Computer equipment		Water tank	
Ceiling fan		Almirah	
Fire extinguisher		Flower pots on chajja or at height	
Kitchen equipment			

7.0 Remarks

7. Summary of the data collected for 16 schools in District Hamirpur for the parameters considered

Sl. no.	Type of school	School name	Wind load resistant	Danger of Stampede	Fire safety provision	Classroom Area m^2	Space allocated @ std./cls.	Length : Width (m)	Aspect ratio	Covered Area m^2	Corridor area m^2	Circulation area %	opening %	Opening*	Illumination value worst	Illumination value best	worst Illumination	Beast Illumination	Road setback
1	Primary school	Bakarati	1	1	0	33.5	45	6.7 : 5	1.3 : 1	110	30	27	14	1	110	260	0	1	1
2		Bralhari	1	0	0	25	33	5.3-6.3 : 4.6	1.2-1.3 : 1	135	48	36	17	1	89	380	0	1	1
3		Chabutra	1	0	1	27	36	5.6 : 4.8	1.2 : 1	185	52	28	13	1	100	280	0	1	0
4		Dundana	1	0	0	19	25-29	4.4-5 : 4.2	1.1-1.2 : 1	142	50	35	19	1	88	284	0	1	1
5		Darogan	1	1	0	26	35	5.7 : 4.6	1.2 : 1	48	14	30	15	1	123	420	0	1	0
6		Panyala	1	1	0	29	40	6 : 4.85	1.2 : 1	190	46	24	19	1	30	200	0	1	1
7		Tal	1	1	1	30	40	6.1 : 4.85	1.3 : 1	150	52	35	22	0	130	407	0	1	1
8	Middle school	Bakarati	1	1	0	26.5	24	5.1-6.2 : 4.75	1.1-1.3 : 1	260	70	27	15	1	98	349	0	1	1
9		Bralhari	1	1	0	30	20-25	6.8 : 4.3	1.6 : 1	235	68	29	18	1	35	224	0	1	1
10		Darogan	1	1	0	25	22	5.5 : 4.5	1.2 : 1	100	29	29	17	1	120	300	0	1	1
11	Senior secondary	Bhota															0	1	
		Pri. Sec. A	1	1	1	31	42	6.2 : 5	1.2 : 1	210	74	35	17	1	80	190	0	1	1
		Pri. Sec. B	1	0	0	28	37	6.1 : 4.6	1.3 : 1	100	40	40	16	1	120	380	0	1	1
		Block C	1	1	1	30	24	7.1 : 4.3	1.7 : 1	125	47	38	21	0	51	208	0	1	1
		Block D	0	1	0	20-35	18-28	5-10 : 4.6	1.1-2.1 : 1	350	64	18	19	1	50	230	0	1	1
12		Chabutra															0	1	
		Block A	1	1	1	30	24	6 : 5	1.2 : 1	220	70	32	14	1	62	274	0	1	0
		Block B	1	1	0	42-77	32-40	5.2-11.2 : 6.9-8.6	1.2-1.7 : 1	420	110	26	12	1	69	253	0	1	1
13		Galore															0	1	
		Block A	0	1	1	22-62	23-50	5-7.9 : 4.8-7.9	1-1.5 : 1	610	177	29	18	1	88	153	0	1	1
		Block B	0	1	1	36-62	25-50	7.4-9.4 : 4.8-7.9	1.2-1.3 : 1	580	180	31	16	1	123	244	0	1	1
14		Kot															0	1	
		Block A	1	1	1	24	19-39	5.3-10.8 : 4.5	1.2- 2.4 : 1	80	24	30	29	0	160	370	1	1	1
		Block B	0	1	1	22	17	5.2-5.6 : 4.2	1.2-1.3 : 1	110	40	36	25	0	130	320	0	1	1
		Block C	0	1	0	12-35	20-34	5.4 -7 : 3 - 5.1	1.1-1.4 : 1	200	60	30	17	0	66	221	0	1	0
15		Nalti															0	1	
		Sci. Block	0	0	1	45-60	36	8-10.6 : 5.6 - 6	1.3-1.9 : 1	180	13	7	32	0	140	380	0	1	1
		Block A	1	1	0	25-30	20-25	5.2-5.9 : 4.8-5.2	1.1-1.2 : 1	270	84	31	19	1	10	170	0	1	1
		Block B	1	1	0	29-36	25-60	5.6 - 7.5 : 4.8 - 5.1	1.2-1.6 : 1	205	45	22	28	0	35	240	0	1	0
16		Tal															0	1	
		Block A	1	0	1	35	28	7.4 : 4.7	1.6 : 1	200	55	28	14	1	118	400	0	1	0
		Block B	1	0	1	33	27	6.9 : 4.8	1.4 : 1	110	36	33	14	1	130	198	0	1	0
		Block C	1	1	0	25-39	22-31	5.1-8.1 : 4.8	1.1-1.7 : 1	180	43	24	12	1	18	161	0	1	1
		Block D	0	1	1	34.5 - 37	28-30	6.6-7.1 : 4.9-5.2	1.4 : 1	350	77	22	20	1	51	409	0	1	1
	No of Counts	0	7	7	15									7			33	0	7
	No of Counts	1	21	21	13									21			1	34	21
		Total	28.0	28.0	28.0									28.0			34.0	34.0	28.0
		% ok	**75.00**	**75.00**	**46.43**									75.00			2.94	100.00	75.00

IMPORTANT NOTES :

Landslide : The area taken up for the survey i.e. Hamirpur is non-landslide prone area except some schools viz high school bralhari, primary school panyala and GSSS kot.

Fire safety provision: cl 6.1 of IS 14435:2013 states that exits from the upper floor should be so located that no point in the floor is more than 22.5 m from the nearest exit.

cl. 8.1 IS 14435:2013 states that no exit doorway shall be less than 1 m in width except assembly halls where door width should not be less than 2 m and cl. 8.2 IS 14435:2013 states that the height of the door shall not be less than 2m.

Furniture: there is no furniture provided for primary schools as per govt norms while for middle schools and secondary schools it is founded in surveys that some schools are fully furnished and others are partially means having furniture in some classrooms only.

Space allocation : @std/cls can be calculated by dividing the classroom area with the space allocated as per cl. 4.3 IS 8827:1983 states for primary it is 0.74 m^2, secondary is 1.26 m^2 per student place respectively.

Circulation area as per codal provision* : in case of singly loaded it must be less than 24% and in doubly or triply loaded it must be less than 18% and it is found in the surveys that most of the schools exceeds this limit except a very few.

Opening*: if the area is less than 20% then its ok (1) else not ok (0).

1 means ok and 0 means not ok.

8. Work to be done in next phase

- Considering additional schools under the sample survey.
- Evaluation of different structural design for the school buildings considering codal provision for conventional dead and live load, earthquake and wind load.
- Studying school design layout for stampede reduced passage in case of fire exit requirement.
- Day-light factor calculation consideration for the determination of window size with an objective to provide every rear point of the classroom with minimum prescribed day-light.
- Acoustical comparison of the classroom layout.
- Building design considering space allocation, classroom design with furniture and circulation areas as per prescribed standard limits.
- Model school design layout with provision of playground, access of buildings by physically retarded students and rain water harvesting.

9. Summary of the work carried out after April 2014 till February 2015

1. The survey format upgraded and a separate format was developed for Reinforced Cement Concrete and Masonary structure. (Layout of revised Format attached - RCC Rapid Visual Survey Format Masonary Rapid Visual Survey Format,)
2. The plan was chalked out to survey 89 senior secondary schools of District Hamirpur. (List attached)
3. Since the survey was to be carried out for such a large sample it was very difficult to generate the summary of the collected data from hard copy format. Hence the Mobile Application was developed so that student can upload the filled data. The mobile application requires a data connection and also GPS connectivity is to be ensured to transmit the data. The guidelines were given to the students so that the maximum uniformity is maintained in the survey. (Guidelines regarding photography and the filling of the format)
4. Once the survey was over the whole data got collected in the excel sheet. (The sheet is not attached the data highly extensive).
5. Further the work is in the process for following
    a. The process to concise the collected data of 89 schools in printable format is going on.
    b. Categorization of the photographs as per the defect categories so that the filled data can be substantiated with the visuals.
    c. Preparation of the layout of the various blocks of the schools (sample attached)
    d. The incorrect and correct construction practice followed in the schools surveyed (Sample attached).
    e. IEC for Principals regarding Incorrect and correct construction practices is being prepared.
6. The complete work will be submitted in due course.

10. *Reinforced Cement Concrete Rapid Visual Survey Format for Schools*

1.0 Basic Aspects

Name Roll number

Name of the school: _____

Edu. Block: _____ CD Block _____ No. of floors and height (m): _____

Usage of the Block:_____ Block No.: _____ No of Students:_____

Block Orientation N-S E-W NE-SW NW-SE

Year of Construction of Building Block: (a) GF _____ (b) FF _____ (c) SF _____

Building Topology: Engineered construction / Non Engineering / Cannot be determined

Check for seismic provisions:

Vertical irregularities yes / no

Plan irregularities yes / no

Irregularities in structure:

Open ground floor	yes / no
Heavy mass at roof	yes / no
Partially filled panels	yes / no
Re-entrant corner	yes / no
Diaphragm discontinuity opening	> 50% / < 50%
Out of plane offsets	yes / no
Non parallel system	yes / no
Staircase connectivity to building	yes /no
Staircases symmetrically placed in plan	yes / no
Reinforcement corrosion	yes / no
Stiffness irregularity	$k_i > 0.7k_{i+j}$ / within limit
Mass irregularity,	$w_i > 2w_{i-1}$ / $w_i > 2w_{i+1}$ / within limit
Dampness,	Exist / does not exist
Roof type	Flat/Sloping roof/Hipped/complex
Roof material	RCC/CGI /Slate / Asbestos
If Sloping,	
(a) Ties	yes / no/ cannot be determined
(b) Bracing	yes / no/ cannot be determined
(c) Roof & Gable band	yes/ no / cannot be determined
(d) False ceiling obstruction	yes / no
Slender columns and deep beams at any beam-column junctions	yes / no
Infill masonary wall made with half brick walls or brick on edge walls?	yes / no
Adjoining buildings separated by less than 2% of building height	yes /no

Building with short column effect	yes / no
Plan aspect ratio of the building	> 2.5 / <2.5
Columns oriented along length of building plan	yes / no
Building with at least three columns along each plan direction	yes / no
Beam-column supports/junctions centrally positioned in all floors	yes / no

Check for wind provision –

Regularity of building	yes / no
Slope 30 - 45 degree	yes / no
Overhang	> 0.5 m / < 0.5
Landslide prone site	yes / yes
and retaining wall protection	yes / no
	no / n.a.

Fire / Stampede Requirement:

Width door	< 1m / > 1m,
Height of door	< 2m / > 2m
Cracks in Wall	Fine /Severe /negligible/not applicable,
Cracks in RCC Column	Fine /Severe /negligible / not applicable
RCC Beam	Fine /Severe /negligible / not applicable
RCC Slab	Fine /Severe /negligible / not applicable

4.0 Constructional Requirements

4.1 Space Allocation

Area of the classroom:	Primary - class I - class V	_____ m^2
	Middle - class VI - class VIII	_____ m^2
	High School	_____ m^2
	Senior Secondary	_____ m^2

Classroom aspect ratio	> 1.5 or < 1.5	
Circulation area	> 24% for single loaded	< 24% for single loaded
	> 18% for double loaded	< 24% for double loaded

4.2 Size of Opening

Location of opening	in one wall / in both walls	
Total Size of openings	< 20 % of floor area for single wall	> 20 % of floor area for
single wall	< 15% for double wall	> 15% for double wall

Staircase:

Tread	< 30 cm / > 30 cm
Riser	< 15 cm / > 15cm

Handrail	< 1 m / > 1.2 m
Number of risers in one flight	> 15 / < 15
Width of the staircase	> 1.5 m / < 1.5 m
Headroom	> 2.2m / < 2.2m

5.0 Functional Requirements

Danger of stampede	yes / no
Road setback	ok / not ok
Provision for rain water harvesting	yes / no
Height of window sill	> 800 mm / < 800 mm
Noise level	> 40 dB / < 40 dB
Type of doors and windows	steel / timber / PVC / Board
Illumination at worst	……lux Illumination at best …… lux

6.0 Non-Structural Components

Potential hazard	Does the item is anchored?	Potential hazard	Does the item is anchored?
Partitions		False ceiling	
Black/green boards		Laboratory equipment	
Bookshelves		Coolers	
Computer equipment		Water tank	
Ceiling fan		Almirah	
Fire extinguisher		Flower pots on chajja or at height	
Kitchen equipment		Brick parapets/ pillars/planters etc	
Roof Chimneys		Signs/display boards	

Flat Roof or Floor:

Steel joist with stone slabs	yes / no
Jack arch roof/ floor	yes / no
RCC or RBC	yes / no
Any other	_____ / n.a.

Pitched roof Understructure:

False ceiling obstruction	yes / no
Bamboo truss/rafter/purlin	yes / no
Wooden truss/rafter/purlin	yes / no
Steel truss/purlin	yes / no
Steel truss/purlin	yes / no
Any other	_____ / n.a.

Pitched Roof Covering:	
Stone slates	yes / no
Burnt Clay Tiles	yes / no
CGI Sheets	yes / no
A.C. Sheets	yes / no
Fiber sheets	yes / no
Any other	_____ /n.a.
Walls Type:	
Earthen / Clay / Mud / Adobe	
UCR Masonary	yes / no
Dressed stone masonary	yes / no
Burnt Brick	yes / no
Cement Concrete Blocks	yes / no
Thickness of wall	_____
Any other	_____ /n.a.
Mortar in Wall:	
Mortar	yes /no
Mud mortar	yes / no
Lime Mortar	yes / no
Cement Mortar	yes / no

Make the sketch of the blocks

Move in the clockwise direction in the school if possible.

Compulsory photographs and rules

Block 1 will be the oldest followed by 2, 3……

1. School name without and with students Fig 1 – 3
2. All building blocks of schools if possible Fig. 4
3. Block wise inauguration plate if exist Fig. 5
4. Block A School building from outside – front / back and side walls Fig 6 -7
5. Photographs as relevant emphasizing on –

crack in col/beam/ wall/slab	corrosion in col/beam/slab, dampness	damage in flooring
anchorage in partition wall	unanchored object	lux reading
sound reading	toilet float valve problem	head room
wall material	bands	slab corrosion
in specify		
Any special incorrect practice		

11. *Masonary Rapid Visual Survey Format for Schools*

1.0 Basic Aspects

Name: Roll number:

Name of the school: _____

Edu. Block: _____ CD Block: _____ No. of floors and height (m): _____

Usage of the Block: _____ Block No.: _____ No of Students: _____

Year of Construction of Building Block: (a) GF _____ FF: _____ SF _____

Orientation N-S E-W

Building Topology: Engineered construction / Non Engineering / Cannot be determined

Check for seismic provisions:

Vertical irregularities	yes / no
Plan irregularities	yes / no
Irregularities in structure:	
Open ground floor	yes / no
Heavy mass at roof	yes / no
Partially filled panels	yes / no
Re-entrant corner	yes / no
Diaphragm discontinuity opening	> 50% / < 50%
Out of plane offsets	yes / no
Non parallel system	yes / no
Staircase connectivity to building	yes /no
Reinforcement corrosion	yes / no
Stiffness irregularity	$k_i > 0.7k_{i+j}$ / within limit
Mass irregularity,	$w_i > 2w_{i-1}$ / $w_i > 2w_{i+1}$ / within limit
Dampness,	Exist / does not exist
Roof type	Flat/Sloping roof/Hipped/complex
Roof material	CGI /Slat / Asbestos
If Sloping,	
(a) Ties	yes / no/ cannot be determined
(b) Bracing	yes / no/ cannot be determined
(c) Roof & Gable band	yes/ no / cannot be determined
(d) False ceiling obstruction	yes / no
Plinth band	yes / no/ cannot be determined
Window sill band	yes / no / cannot be determined
Roof band	yes / no / cannot be determined
Vertical reinforcement at corners	yes /no / cannot be determined

Vertical reinforcement at junctions	yes / no / cannot be determined
Vertical reinforcement at jambs	yes / no / cannot be determined
of openings	
Whether wall length/thickness ratio	< 35 / > 35
Any wall length	> 8 m / < 8m,
wall ht. /thk. ratio	< 15 / > 15
% of opening	> 0.5 for one storey > 0.42 for two storey
	> 0.33 for two storey < 0.50 for one storey
	< 0.42 for two storey < 0.33 for two storey
Location of opening	> 2ft from corner / < 2ft from corner
Distance between openings	> 2ft / < 2ft
Check for wind provision –	
Regularity of building	yes / no
Slope 30 -45 deg.	yes / no
Overhang	> 0.5 m / < 0.5
Landslide prone site	yes / yes
and retaining wall protection	yes / no
	no / n.a.
Fire / Stampede Requirement:	
Width door	< 1m / > 1m,
Height of door	< 2m / > 2m
Cracks in Wall	Fine /Severe /negligible/not applicable,
Cracks in Masonary Column	Fine /Severe /negligible / not applicable,
Cracks in Wooden Column	Fine /Severe /negligible / not applicable
Cracks in Wooden Beam	Fine /Severe /negligible / not applicable
Cracks in Wooden Floor	Fine /Severe /negligible / not applicable
Cracks in RCC Column	Fine /Severe /negligible / not applicable
RCC Beam	Fine /Severe /negligible / not applicable
RCC Slab	Fine /Severe /negligible / not applicable

4.0 Constructional Requirements

4.1 SPACE ALLOCATION:

Area of the classroom:	Primary - class I- class V	_____ m^2
	Middle - class VI - class VIII	_____ m^2
	High School	_____ m^2
	Senior Secondary	_____ m^2

Classroom aspect ratio	> 1.5 or < 1.5	
Circulation area	> 24% for single loaded	< 24% for single loaded
	> 18% for double loaded	< 24% for double loaded

4.2 SIZE OF OPENING:

Location of opening	in one wall / in both walls	
Total Size of openings	< 20 % of floor area for single wall	> 20 % of floor area for single wall
	< 15% for double wall	> 15% for double wall

STAIRCASE:

Tread	< 30 cm / > 30 cm
Riser	< 15 cm / > 15cm
Handrail	< 1 m / > 1.2 m
Number of risers in one flight	> 15 / < 15
Width of the staircase	> 1.5 m / < 1.5 m
Headroom	> 2.2m / < 2.2m

5.0 Functional Requirements

Danger of stampede	yes / no		
Road setback	ok / not ok		
Provision for rain water harvesting	yes / no		
Height of window sill	> 800 mm / < 800 mm		
Noise level	> 40 dB / < 40 dB		
Type of doors and windows	steel / timber / PVC / Board		
Illumination at worst	……lux	Illumination at best	…… lux

6.0 Non-Structural Components

Potential hazard	Does the item is anchored?	Potential hazard	Does the item is anchored?
Partitions		False ceiling	
Black/green boards		Laboratory equipment	
Bookshelves		Coolers	
Computer equipment		Water tank	
Ceiling fan		Almirah	
Fire extinguisher		Flower pots on chajja or at height	
Kitchen equipment		Brick parapets/ pillars/planters etc.	
Roof Chimneys		Signs/display boards	

Masonary Building Typology:

Flat Roof or Floor:	
Wooden joist with earth fill	yes / no
Steel joist with stone slabs	yes / no
Jack arch roof/ floor	yes / no
RCC or RBC	yes / no
Any other	_____ / n.a.
Pitched roof Understructure:	
False ceiling obstruction	yes / no
Bamboo truss/rafter/purlin	yes / no
Wooden truss/rafter/purlin	yes / no
Steel truss/purlin	yes / no
Steel truss/purlin	yes / no
Any other	_____ / n.a.
Pitched Roof Covering:	
Stone slates	yes / no
Burnt Clay Tiles	yes / no
CGI Sheets	yes / no
A.C. Sheets	yes / no
Fiber sheets	yes / no
Any other	_____ /n.a.
Walls Type:	
Earthen / Clay / Mud / Adobe	
Bamboo	yes / no
Wooden	yes / no
UCR Masonary	yes / no
Dressed stone masonary	yes / no
Burnt Brick	yes / no
Cement Concrete Blocks	yes / no
Thickness of wall	_____
Any other	_____ /n.a.
Mortar in Wall:	
Mortar	yes /no
Mud mortar	yes / no
Lime Mortar	yes / no
Cement Mortar	yes / no

Make the sketch of the blocks:

Move in the clockwise direction

Compulsory photographs and rules

Block A will be the oldest followed by B, C……

1. School name without and with students Fig 1 – 3
2. All building blocks of schools if possible Fig. 4
3. Block wise inauguration plate if exist Fig. 5
4. Block A School building from outside – front / back and side walls Fig 6 -7
5. Photographs as relevant emphasizing on –

Crack in col/beam/ wall/slab	Corrosion in col/beam/slab, Dampness	Damage in flooring
Anchorage in partition wall	Unanchored object	Lux reading
Sound reading	Toilet float valve problem	Head room
Wall material	Bands	Slab
Corrosion if specify		
Any special incorrect practice		

Make the sketch of the blocks

Move in the clockwise direction in the school if possible.

Compulsory photographs and rules

Block 1 will be the oldest followed by 2, 3……

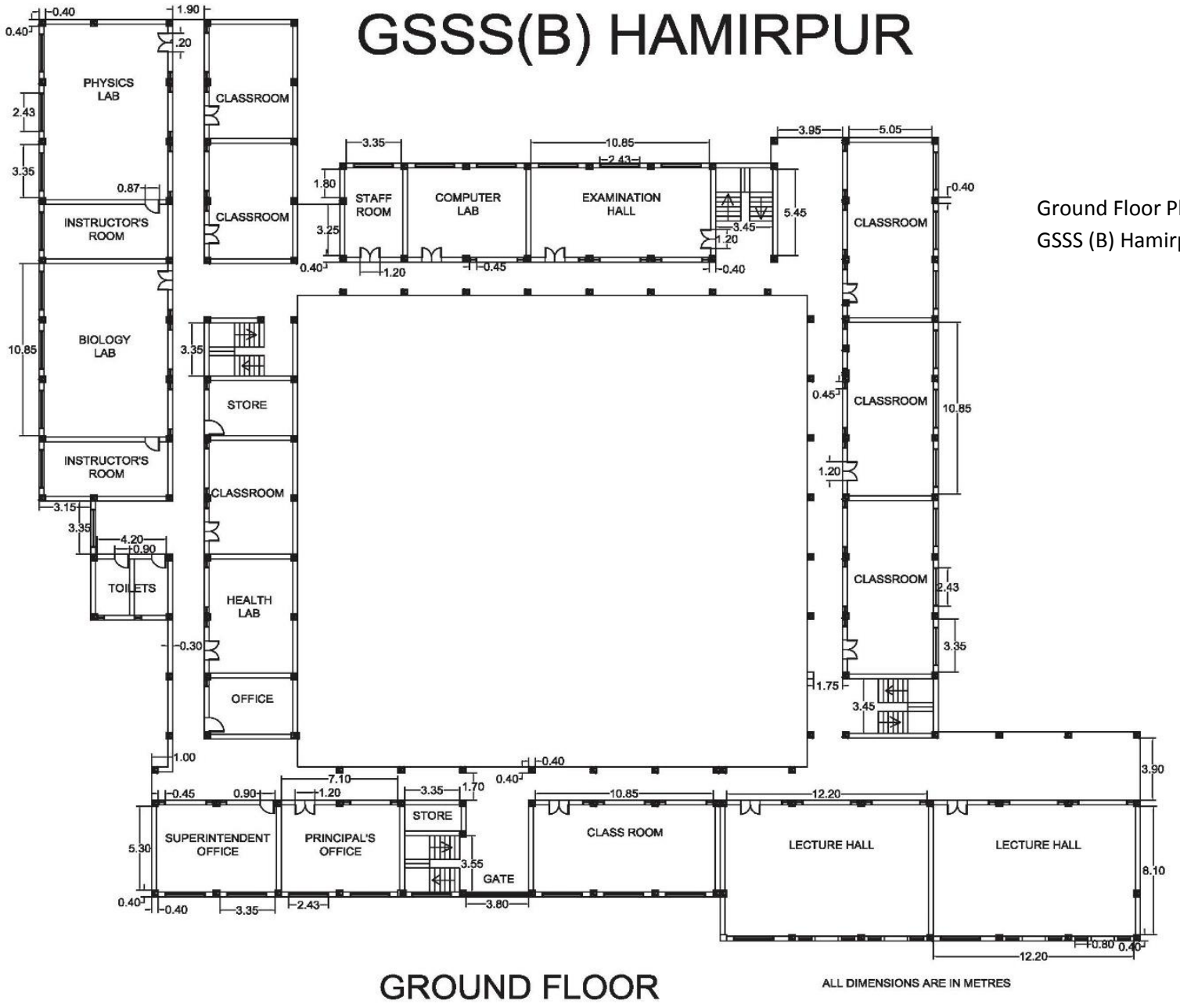
1. School name without and with students Fig 1 – 3
2. All building blocks of schools if possible Fig. 4
3. Block wise inauguration plate if exist Fig. 5
4. Block A School building from outside – front / back and side walls Fig 6 -7
5. Photographs as relevant emphasizing on –

Crack in col/beam/ wall/slab	Corrosion in col/beam/slab, Dampness	Damage in flooring
Anchorage in partition wall	Unanchored object	Lux reading
Sound reading	Toilet float valve problem	Head room
Wall material	Bands	Slab
Corrosion if specify		
Any special incorrect practice		

12. **List of Senior Secondary Schools in District Hamirpur (H.P.) surveyed**

Sr. No.	Name of Institution	Est. Distance from Hamirpur (Kms)	Roll No	Name of Student	Roll No	Name of Student
1	Amlehar	32	12189	P. S. Reddy	12169	Yakul Dogra
2	Amroh	9	12165	Sristi Sarika	12156	Rohan Sharma
3	Badhani	34	12150	Rajarshi Bhar	12157	Parth Mawai
4	Badaran	20	12174	Yugant Kapur	12177	Vishvesh Bisht
5	Bagwara	22	12157	Parth Mawai	12150	Rajarshi Bhar
6	Bajrol	44	12104	Ankit Yadav	12146	Nishant Thakur
7	Balduhak	23	12185	Vikram Bishnoi	12188	Satyam Pandey
8	Bani	28	12138	Nishant Chauhan	12164	Sahil
9	Bara	39	12162	Kuldeep Gaurav	12176	Vinod Kr Jaiswal
10	Bhaleth	20	12156	Rohan Sharma	12165	Sristi Sarika
11	Barsar	31	12134	Himesh Kumar	12152	Surya Attri
12	Batran	22	12122	Pavan Verma	12155	Shubham Sood
13	Bahanwin	37	12105	Arpit Sood	12113	Sushil Kumar
14	Bharari	39	11174	Prahlad Kumar	10126	Vinay Kumar
15	Bhooranj	21	10126	Vinay Kumar	11174	Prahlad Kumar
16	Bhota	13	12125	Vikas Meena	12111	Ashwin Goswami
17	Bhumpal	15	12167	Simranjeet Singh	12136	Vibhour Sharma
18	Bhukkar	44	12145	Imroj Khan	12149	Shubham Sankhala
19	Biar	32	12139	Abhishek Singh	12178	Mayank Jain
20	Bijhari	31	12135	Aditya Yadav	12141	Vijay Kumar
21	Bir Bagehra	95	12128	Gaurav kr Verma	12179	Ashish Kr Saxena
22	Bohani	7	12142	Banbari L Meena	12143	Amit Kumar Meena
23	Chabutra	12	12131	Akshit Chauhan	12129	Karnail Singh
24	Chamboh	26	12176	Vinod Kr Jaiswal	12162	Kuldeep Gaurav
25	Chouri	39	12117	Rohit Sharma	12118	Rakesh Kumar
26	Choru	42	12161	Abhi Joshi	12180	Mukul Jain
27	Darbiar	23	12149	Shubham Sankhala	12145	Imroj Khan
28	Dhaneta	27	12118	Rakesh Kumar	12117	Rohit Sharma
29	Dhangota	38	12147	Vaibhav Dua	12160	Sawan Kadyan
30	Dhabiri	54	12180	Mukul Jain	12161	Abhi Joshi
31	Didwin	10	11106	Arun Chanotra	12109	Sakshi Sharma
32	Dandru	31	12127	Dheeraj Thakur	12123	Nikhil Thakur
33	Galore	24	12130	Vijay Pal Bana	12163	Dinesh Saran
34	Gaarli	43	12170	Dushyant Saini	12169	Yakul Dogra
35	Gauna	33	12168	Ankit Parmar	12175	Sanchit Mahajan
36	Ghangot	43	12123	Nikhil Thakur	12127	Dheeraj Thakur
37	Giara Gran	39	12184	Md. Shadab Razi	12186	Vijaya N Pandey
38	Hamirpur (B)	0	12102	Aditya Bindra	12101	Amandeep Kalra
39	Hamirpur (G)	0	12101	Amandeep Kalra	12102	Aditya Bindra
40	Hareta Lower	28	12177	Vishvesh Bisht	12174	Yugant Kapur
41	Hareta Upper	26	12178	Mayank Jain	12139	Abhishek Singh
42	Jahu	37	12103	Nishant Gupta	12112	Abhinav
43	Jalari	23	12136	Vibhour Sharma	12167	Simranjeet Singh
44	Jandru	41	12143	Amit Kr Meena	12142	Banbari Lal Meena
45	Jangle Beri	35	12179	Ashish Kr Saxena	12128	Gaurav Kr Verma

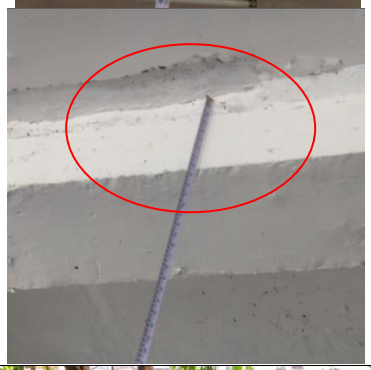
47	Joure Amb	39	12171	Saurabh Sharma	12173	Saurabh Gupta
48	Jhagriani	16	12144	Abhishek Vijay	12133	Avinash Rawat
49	Jhiralri	15	12111	Ashwin Goswami	12125	Vikas Meena
50	Jol Sapper	11	12119	Ajay Kumar	12110	Anand Kr Dogra
51	Kakkar	47	12158	Navin Kumar	12172	Rohit Sharma
53	Kakriar	9	12181	Rohit Anand	12183	Harman S Sidhu
54	Kangoo	13	12124	Mani Mosam	12132	Shashwat Mittal
55	Karot	28	12183	Harman S Sidhu	12181	Rohit Anand
56	Kashmir	28	12133	Avinash Rawat	12144	Abhishek Vijay
57	Kharwar	23	12160	Sawan Kadyan	12147	Vaibhav Dua
58	Kot	8	12106	Puneet Negi	12120	Gagan Deep
59	Kulhera	23	12173	Saurabh Gupta	12171	Saurabh Sharma
60	Kuthera	7	12129	Karnail Singh	12131	Akshit Chauhan
61	Ladrour	24	12148	Rakesh Choudhary	12153	Jayram Matwa
62	Lambloo	10	12126	Bidur Kumar	12182	Manish Kr Mittal
63	Maharal	46	12152	Surya Attri	12134	Himesh Kumar
64	Mair	19	12172	Rohit Sharma	12164	Sahil
65	Manoh	30	12113	Sushil Kumar	12105	Arpit Sood
66	Matahni	6	12182	Manish Kr Mittal	12126	Bidur Kumar
67	Mehal	20	12153	Jayram Matwa	12148	Rakesh Choudhary
68	Mundkhar	32	12112	Abhinav	12103	Nishant Gupta
69	Nadaun (B)	26	12166	Ankit Sharma	12115	Mukesh
70	(Nadaun (G)	26	12115	Mukesh	12166	Ankit Sharma
71	Nalti	13	12163	Dinesh Saran	12130	Vijay Pal Bana
72	Parol	18	12107	Manish Chowdhary	12108	Praveen Bhardwaj
73	Patlander	33	12110	Anand Kr Dogra	12119	Ajay Kumar
74	Patta	21	12108	Praveen Bhardwaj	12107	Manish Chowdhary
75	Pohanj	45	11136	Ashok Bharti	12186	Vijaya N Pandey
76	Rail	16	12155	Shubham Sood	12122	Pavan Verma
78	Raili Jajri	52	11121	Ankush Kumar	12184	Md. Shadab Razi
79	Sanahi	24	12159	Saumitra Kumar	12114	Piyush V Shukla
80	Samtana	30	12116	Hemant Kumar	11117	Nikhil Chandel
81	Sera	35	12175	Sanchit Mahajan	12168	Ankit Parmar
82	Sohari	26	12141	Vijay Kumar	12135	Aditya Yadav
83	Sujanpur	24	12132	Shashwat Mittal	12124	Mani Mosam
84	Tal	10	12109	Sakshi Sharma	11106	Arun Chanotra
85	Touni Devi	13	12120	Gagan Deep	12106	Puneet Negi
86	Tikkar Khatrian	20	12114	Piyush Vl Shukla	12159	Saumitra Kumar
87	Tippar	30	12146	Nishant Thakur	12104	Ankit Yadav
88	Uhal	22	11132	Rajinder Singh	11149	Chandan M Tiwari
89	Utpur	53	11149	Chandan M Tiwari	11132	Rajinder Singh
90	Data Compilation		12140	Krisha	12187	Jayoti Sheoran

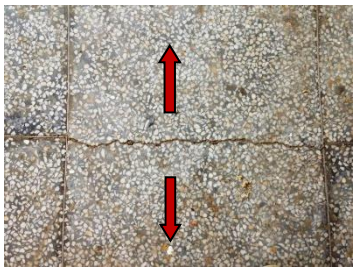


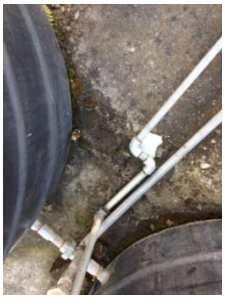
Ground Floor Plan Layout of GSSS (B) Hamirpur

14. Aspects of Construction practices in Government Senior Secondary School (Boys) – Hamirpur (H.P.)

Sl. no.	Walls and Exterior	Incorrect Practice	Correct Practice
1.	 	The roof slab is not treated for waterproofing. Moreover the brick infill has not been plastered leading to dampness.	Proper plaster and waterproofing treatment must be given to roof slab to avoid the problem of dampness.
2.		Faulty infill wall construction	In RCC framed structure, the infill walls must be properly finished with proper allowance.
	Beams		
3.	 	Reinforcement corrosion in the beams. This is owing to inadequate concrete cover and the concrete being porous.	Porosity in concrete must be addressed in the construction stage.

4.	 	Depth of beam is different at different locations along the span. It may be due to fault in shuttering and poor workmanship	Scaffolding must be placed properly and a strict check on the workmanship is necessary.
5.	 	Inverted beams in the roof slab with improper drainage lead to accumulation of water. The effects of dampness are visible	Whenever inverted beam slab construction is taken up, care must be taken to provide a proper roofing or efficient drainage

6.		Unfinished slab with reinforcement projecting out.	Excess reinforcement must be trimmed and all slab edges must be finished to avoid a safety hazard
7.	 	Reinforcement corrosion in case of a slab of the building. It may be due to porosity of the concrete or inadequate cover to the slab	The shuttering and workmanship requires supervision to ensure proper cover and good non-porous concrete mix
8.		Differential settlement at the ground floor level has caused the floor to crack	The ground must be prepared properly during laying the foundation to ensure the plinth and floor do not suffer from settlement

NON STRUCTURAL ELEMENTS	Incorrect Practice	Correct Practice
   	The lids of water tanks are not provided. The water often overflows causing dampness on the roof slab	Thee lids of water tanks must be securely in place. Float valve must be used to prevent overflow

 	Service ducts in the student washrooms are left open. This poses a great hazard for all the occupants of the building.	Service ducts must me safely closed with proper door shutters and locked to prevent any mishap
 **Fixed Glass**	The exhaust fan is simply fitted for formality sake over an existing glass ventilator.	Before fitting the exhaust fan, it is necessary that the glass behind must be removed

15. Concept of waterless urinals

Economic Benefits

Conventional Urinals	*Waterfree Urinal System*
Consumes between 70,000 to 3,00,000 liters of water per year	ZERO water consumption
Annual combined water and sewer costs	Cartridge at a fraction of water and sewer costs
Annual operating costs equivalent to 50 to 200 percent of purchase price	Average initial purchase cost payback period of 3 months to 2 years
High-maintenance costs related to repair of mechanical parts	No breakable mechanical parts or components = low maintenance costs

Comparison between Zerodor, Menbrane trap & Sealant liquid trap

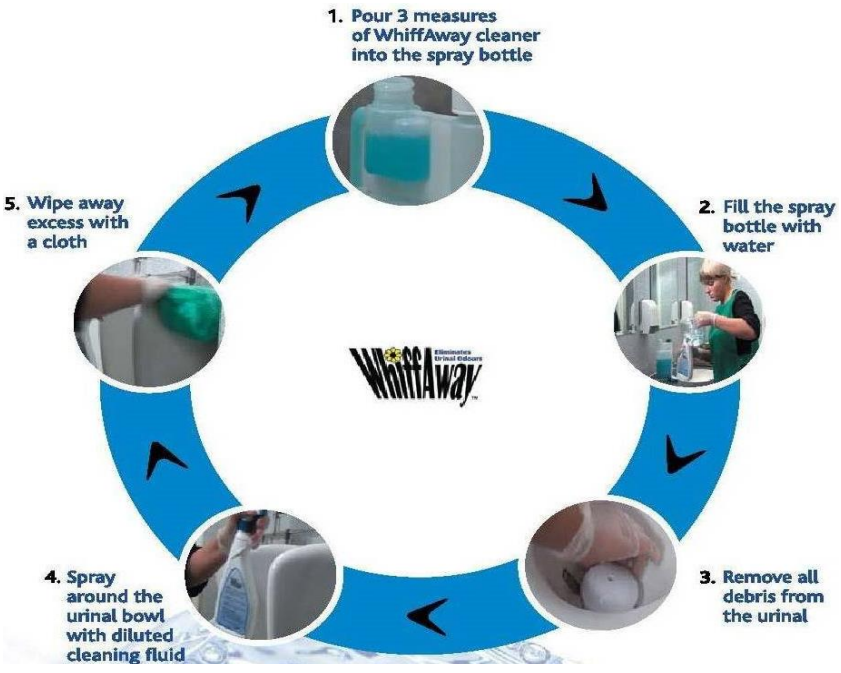
Description	Zerodor[(a)]	Membrane Trap[(b)]	Sealant Liquid Trap[(c)]
Mechanism of Operation	Ball valve prevents odour	LDPE membrane prevents odour	Liquid seal prevents odour
Cost of New System	Cheaper than the existing solutions	Cost of entire system - Rs. 5600/-	Cost of entire system - Rs. 10000/- to 12000/-
Replacement of Parts	No replacement needed	Membrane needs to be replaced	Sealant liquid and cartridge need to be replaced at least 4-5 times a year
Maintenance Cost	No recurring expenditure	Rs. 1000/- to 1200/- (trap needs to be replaced at least once in 6 months)	Rs. 2475/- (Sealant liquid Rs. 1700/- and Cartridge liquid Rs. 775/- for urinals with 50 users per day, needs to be replaced at least 4-5 times a year)
Maintenance Routine Involves	Ball to be retracted from the trap and cleaned	Trap has to be dismantled from urinal and waste pipe	a)Liquid seal replacement for every 1000 uses b)Replacement of cartridge 4-5 times a year
Time Required for Maintenance	10 minutes	30 minutes	10 minutes
Retrofitting of Existing Urinals	Traps can be installed in existing urinals	Traps can be installed in existing urinals	New pans have to be installed
Issues/Constraints	Nil (Limited dependence on suppliers)	Supply of membranes	Supply of cartridge and sealant liquid

[(a)] Data based on manufacturer of zerodor Ekam Eco Solutions Pvt. Ltd., New Delhi

[(b)] Data based on manufacturer of membrane traps Enswico AG, Switzerland

[(c)] Data based on manufacturer of sealant liquid based waterless urinals Parryware Roca (Falcon Waterfree)

Whiff-away Cleaning Regime

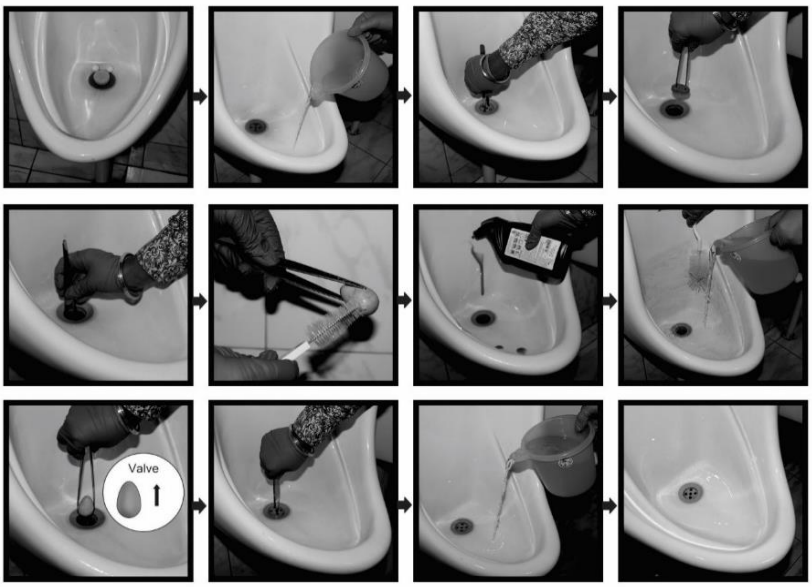


Zerodor Waterless urinals

zerodor™
saves water, removes odour

ekam
ECO SOLUTIONS
www.ekamecosolutions.com

अपने युरिनल को कैसे साफ करे



क्या न करें

- युरिनल की सफाई के लिये केमिकल या ब्लीच का प्रयोग न करें।
- युरिनल की सफाई के लिये एसिड का प्रयोग न करें।
- गन्दे पानी को युरिनल में न डालें।
- पान, गुटखा इत्यादि युरिनल में न थूकें।

क्या करें

- युरिनल की सफाई करते समय ग्लव्स का प्रयोग करें।
- प्रतिदिन एक से दो बार युरिनल को पानी से अवश्य साफ करें।
- अच्छे परिणाम के लिये NRV Valve और Zerodor™ को सप्ताह में एक बार Descaling Agent से जरूर साफ करें।

16. Parametric Study of Functional, Structural and Non-structural components of Government Senior Secondary Schools

The schools have been surveyed for the building blocks constructed with different number of floors. It was found the maximum of building blocks (approx. 70%) are constructed upto two storeys, with 20% building having one storey and a few (approx. 10%) buildings having three storeys. Thus some building blocks are under-utilized.

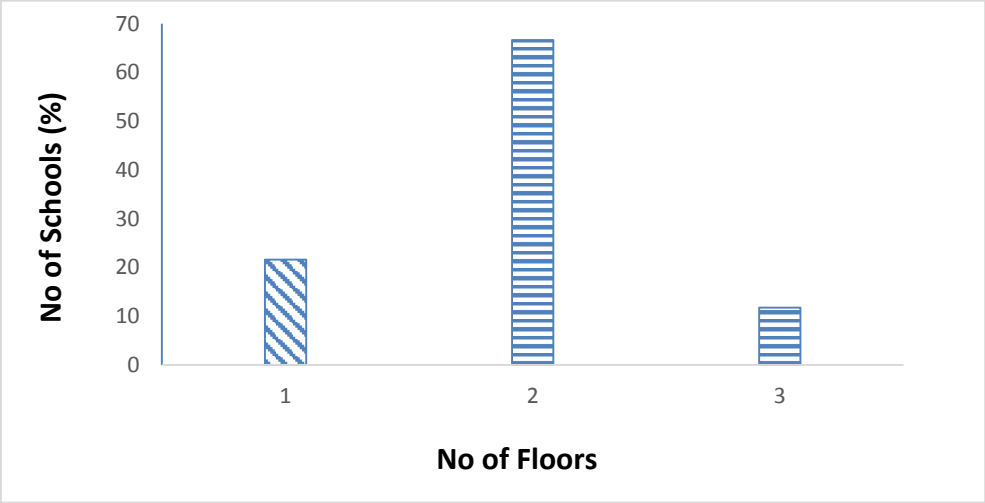
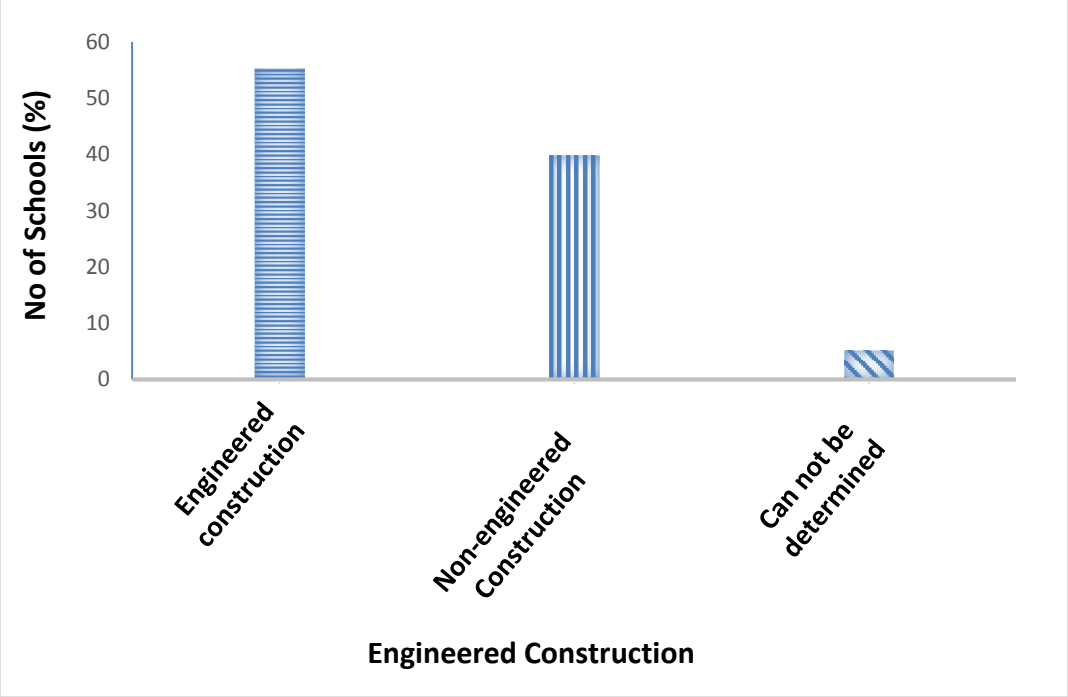
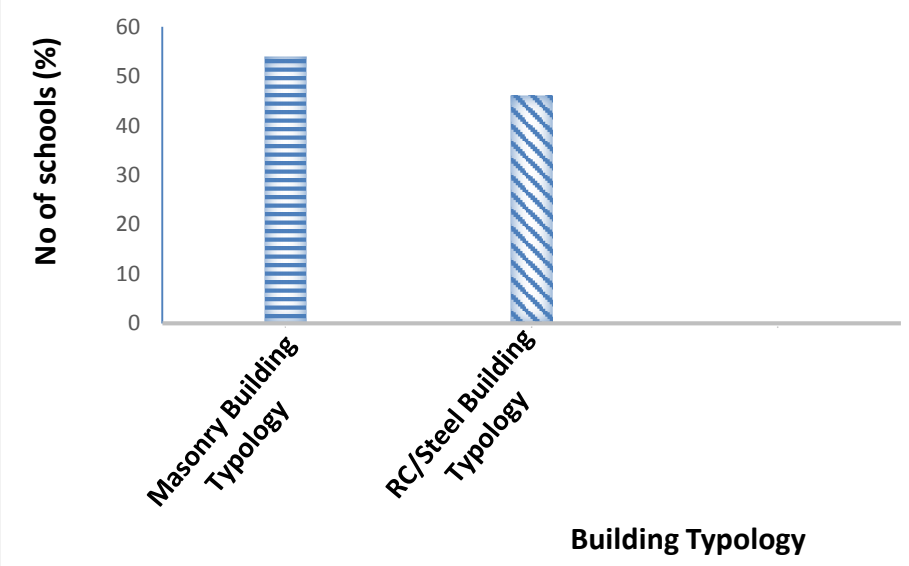


Fig. 16.1 : School building blocks with different number of floors

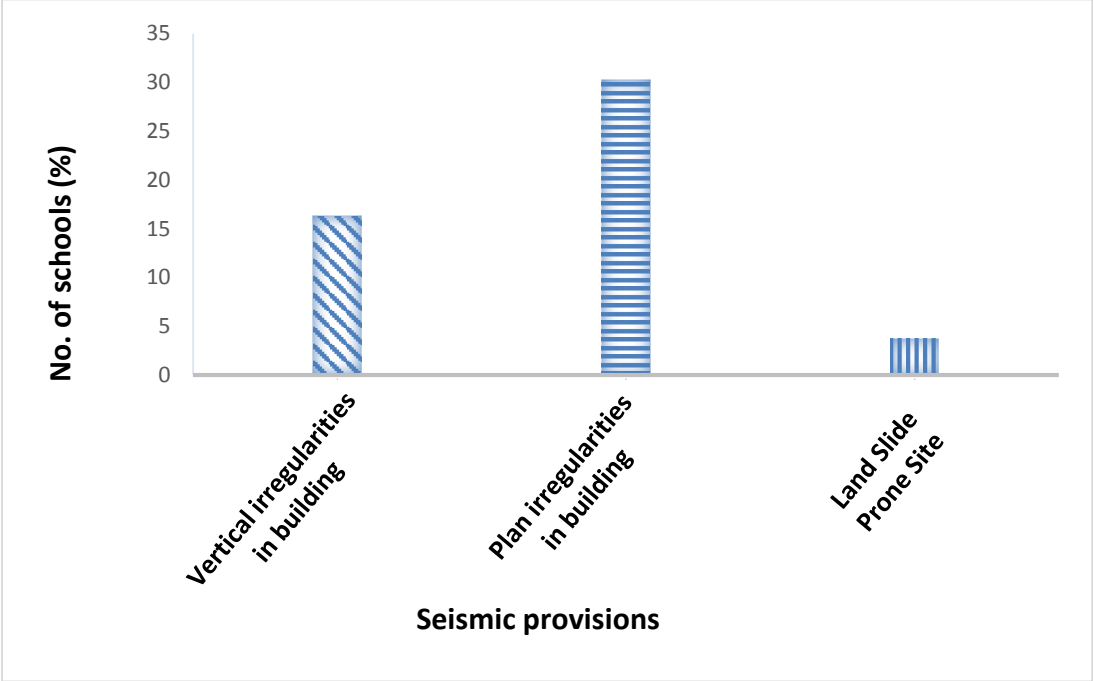
The schools were surveyed to check whether the building blocks are engineered or non-engineered constructions. It was observed that more than half of the buildings (approx. 55%) are engineered constructions (i.e. RCC), whereas approx. 40% buildings are non-engineered constructions.



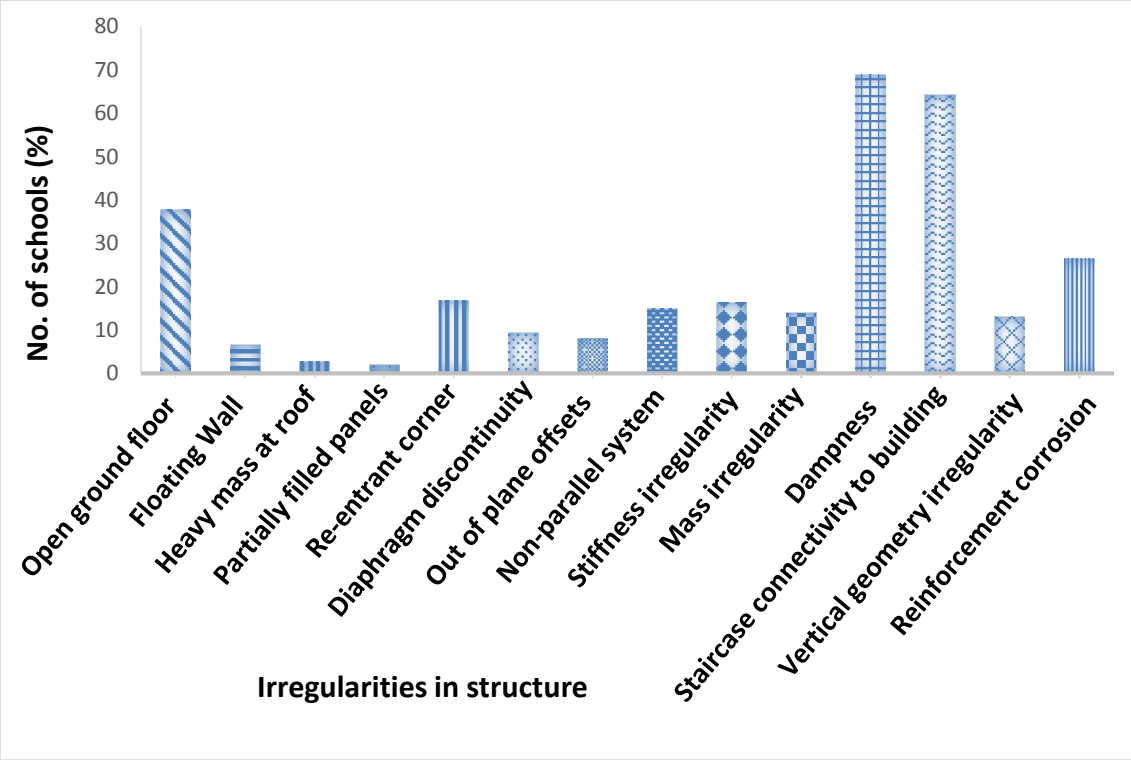
The school buildings were also surveyed for different types of typologies; i.e. whether the buildings are constructed of Masonry or RCC. Masonry buildings have load-bearing walls, i.e. whole load is transferred to foundation through walls; whereas RCC buildings have frame action (Slab-Beam-Column) for transferring load to foundation. In some cases, it becomes difficult to differentiate between a masonry and concrete building due to plastered surface. In this survey, more than half of the buildings were found to be of masonry type and rest were of RCC type. These results are bit contradictory to the results of engineered/non-engineered constructions, it may be attributed to the discrepancy of the input given by the surveyors.



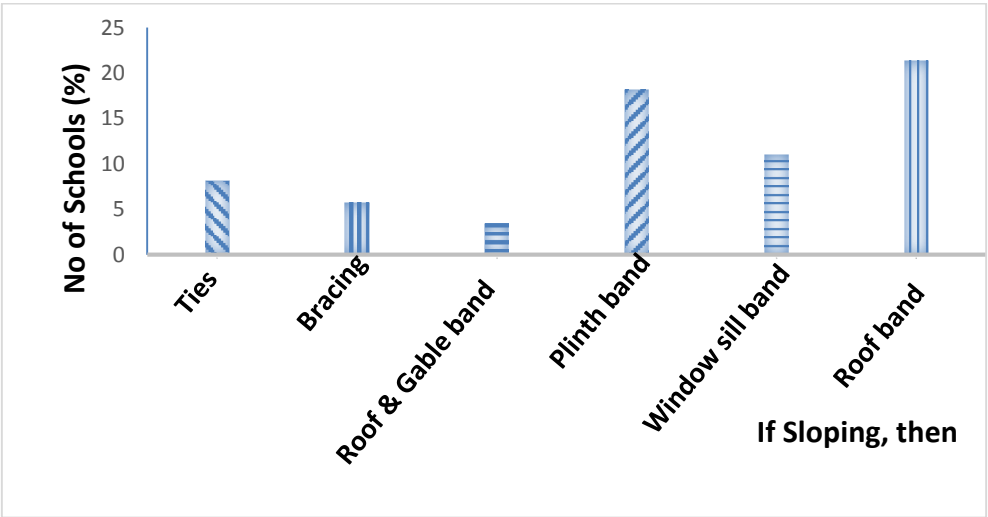
As major part of Himachal Pradesh belongs to seismic zone V, the buildings were checked for seismic provisions. It was found that buildings have plan and vertical irregularities. Any expansion of the building blocks should be carried out in a manner that decreases and not increase the irregularity.



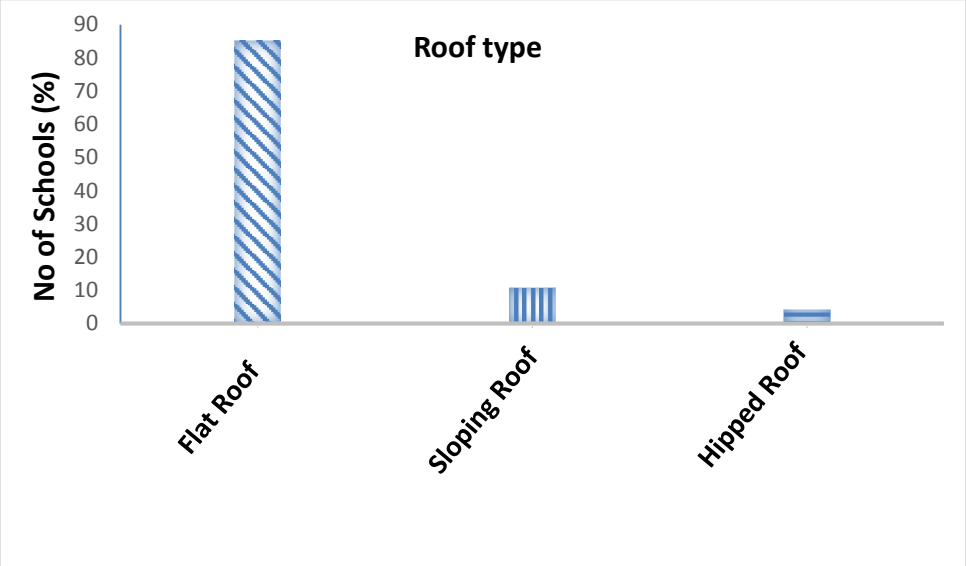
This part of survey was carried out to find out the various irregularities and other parameters which affect the behaviour of school building blocks during earthquake. It was found that dampness, staircase connectivity to building, open ground floor and reinforcement corrosion are the major problems. The dampness could be countered with the provision of the damp-proof course in masonry as a correct construction practice. The open ground floor construction can be avoided by constructing the first floor masonry wall only above the masonry walls of the ground floor. The corrosion of reinforcement can be avoided by following good construction practice.



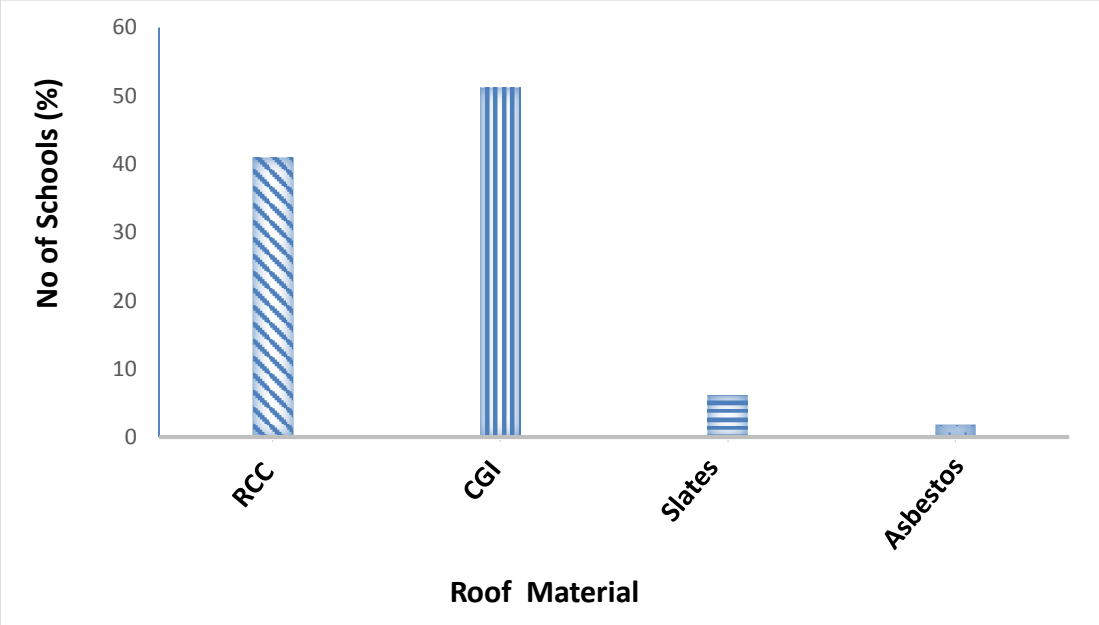
As per IS 4326:1993, provision of band for improving the earthquake resistance of the building is described. It was observed that the school building blocks are highly deficient with respect to the provision of earthquake resistant bands. The provision of earthquake resistant features can only be ensured with effective sensitization of construction workers towards hazard resistant conception.



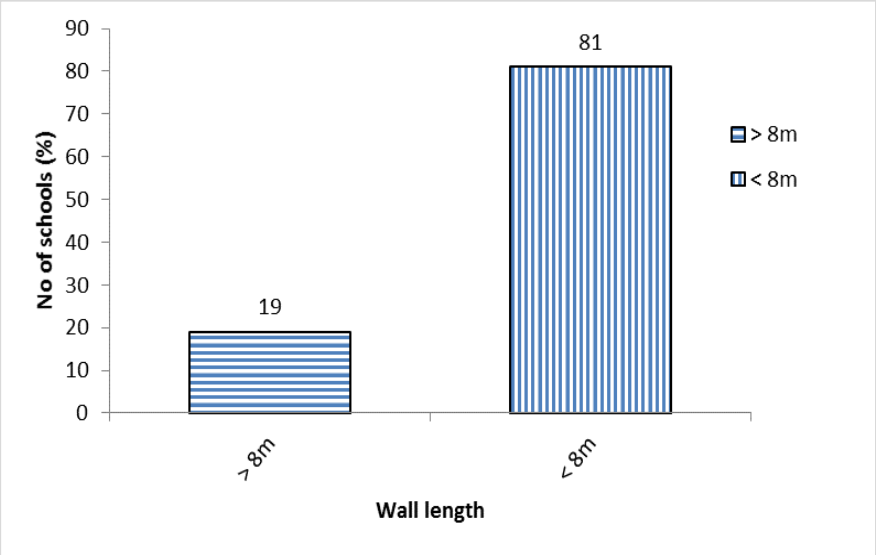
The buildings were surveyed to check for roof type – whether there are flat roof or sloping roof or hipped roof. From the survey, it was concluded that about 85% of buildings have flat roof, and very few buildings have sloping roof (10%) and hipped roof (5%). This is attributed to moderate slopy region.



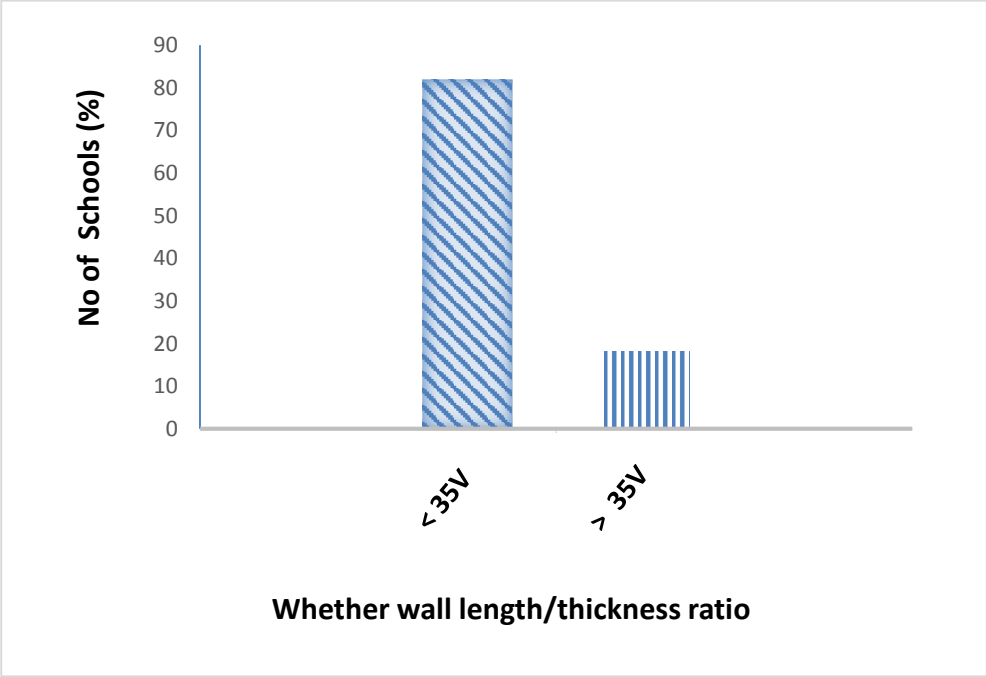
A part of the survey was carried out to find the roof material. As shown in the bar chart below, most of the buildings have either RCC roof or CGI sheet roof; whereas a few buildings have slate or asbestos as roof material. This could be due to the fact that Hamirpur is not at higher altitude.



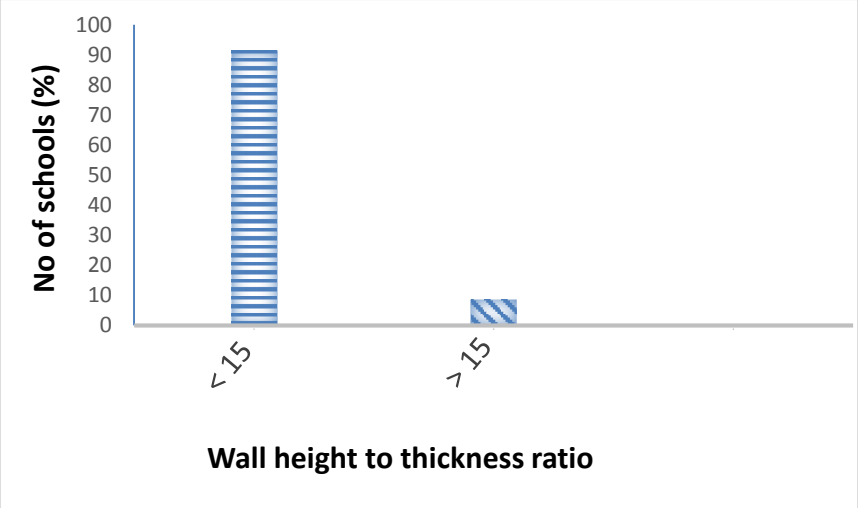
The out-of-plane failure probability for the wall longer than 8 meter is very high. Hence the maximum length of wall in school buildings were considered for study. It has been found that 20% of buildings have walls of length more than 8m. This is mainly due to some portion of the building blocks are used as hall for assembly purposes.



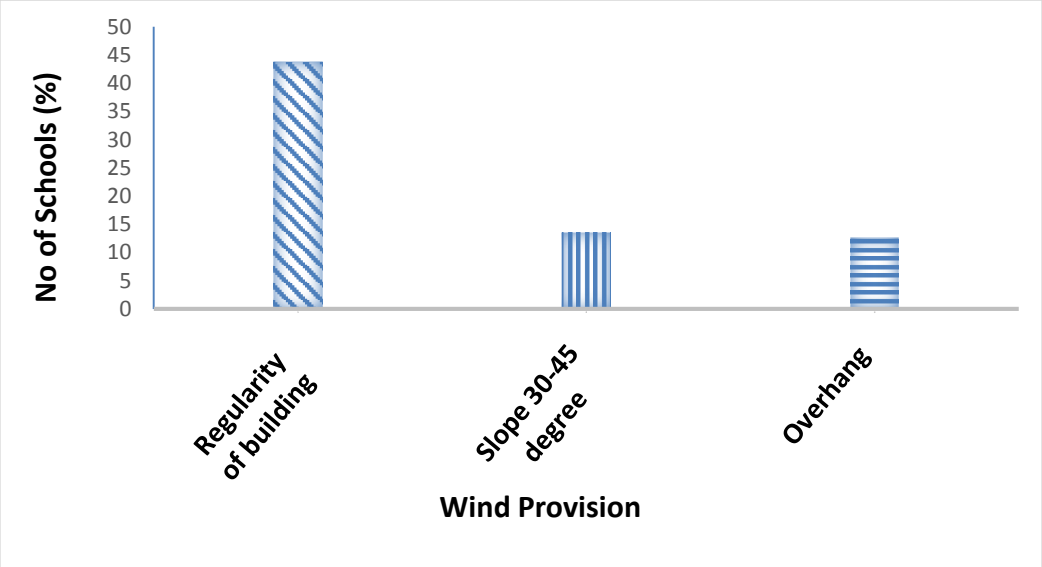
The wall with greater slenderness ratio has a higher tendency towards out-of-plane failure. Hence the wall height/thickness ratio was checked against a benchmark of 35 as specified in IS 13935:2009. In this survey, 20% of the buildings were found having higher slenderness ratio. This is due to the fact that the buildings are constructed of half-brick instead of one brick thickness.



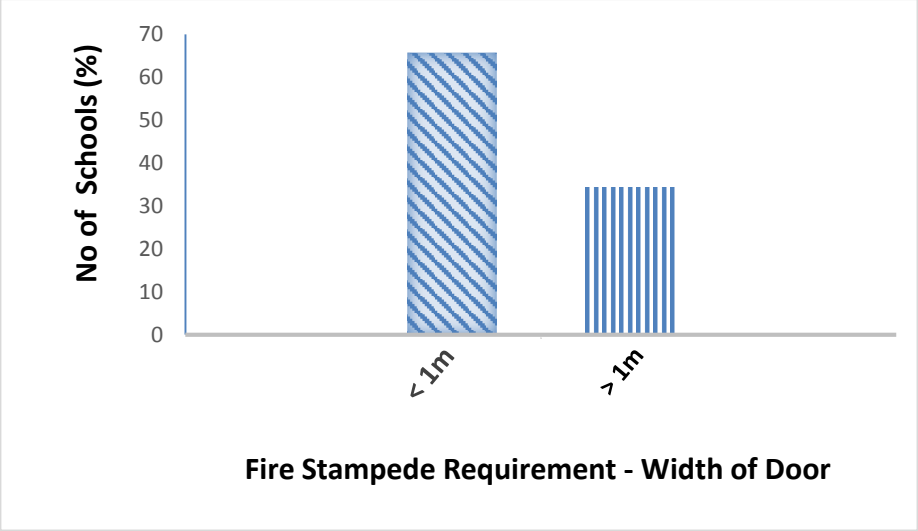
From the results from survey done of the school building blocks, wall height to thickness ratio was found out against a benchmark of value 15 as specified in IS 13935:2009. It was found that very few buildings have the ratio more than 15.



The roofs of the building blocks have been checked for wind provision compliance and in the survey more than half of the buildings have been found to be irregular.

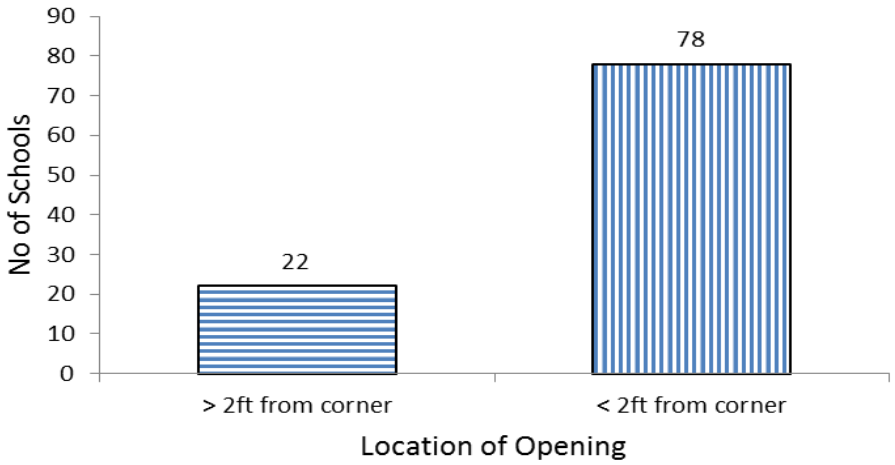


According to Fire Stampede Requirement, the buildings were categorized against door width; whether width of door is greater or less than 1 meter. From the survey, it came out that 65% of buildings have doors less than a meter and 35% have doors wider than 1 meter.

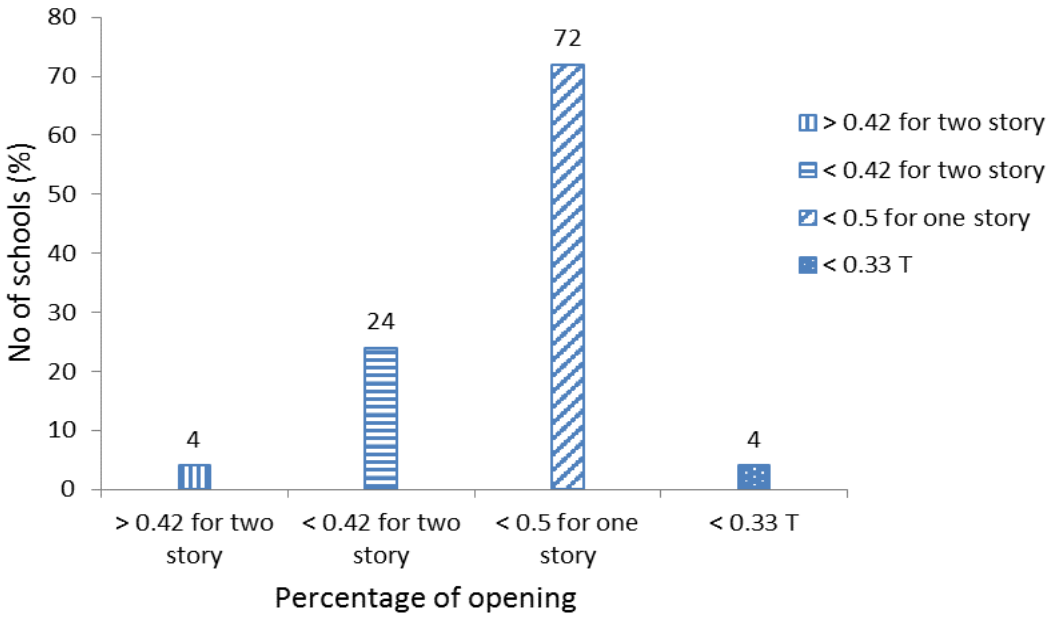


For the same reason mentioned above, height of doors were also measured and categorized against a benchmark of 2 meter. It was seen that about 80% of buildings have doors less than 2 meter height and rest have doors higher than 2 meter.

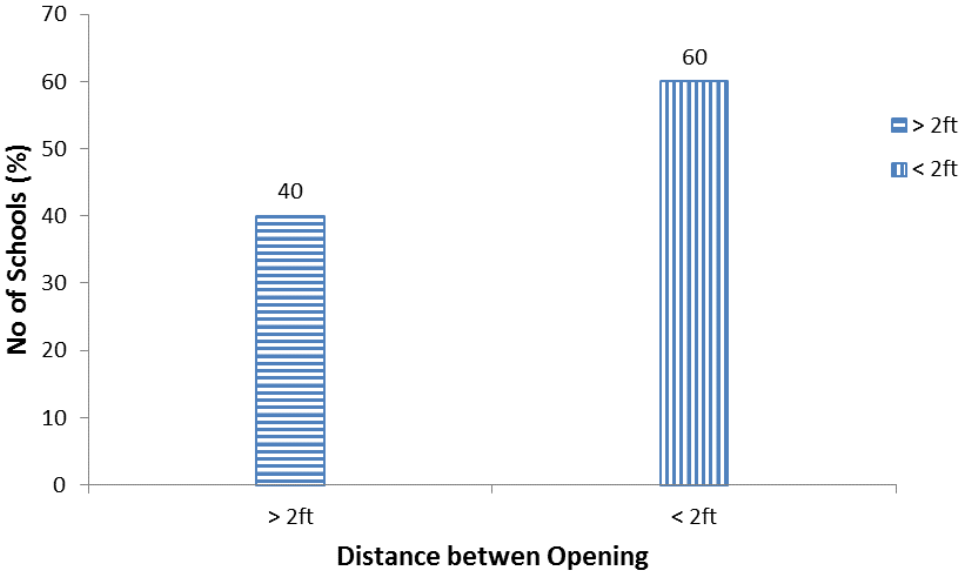
As corners of the non-engineered buildings get affected during earthquakes, hence providing openings near the corners becomes major parameter in deciding the building's behaviour in earthquake. Hence location of openings were surveyed and they were categorized against a safe distance of 2' from corner as per IS 4326:1993. It was found that approximately every 3 out of 4 buildings have openings at less than 2' from corner, whereas only one-fourth buildings have the opposite, i.e. only those one-fourth buildings are safer than the rest.



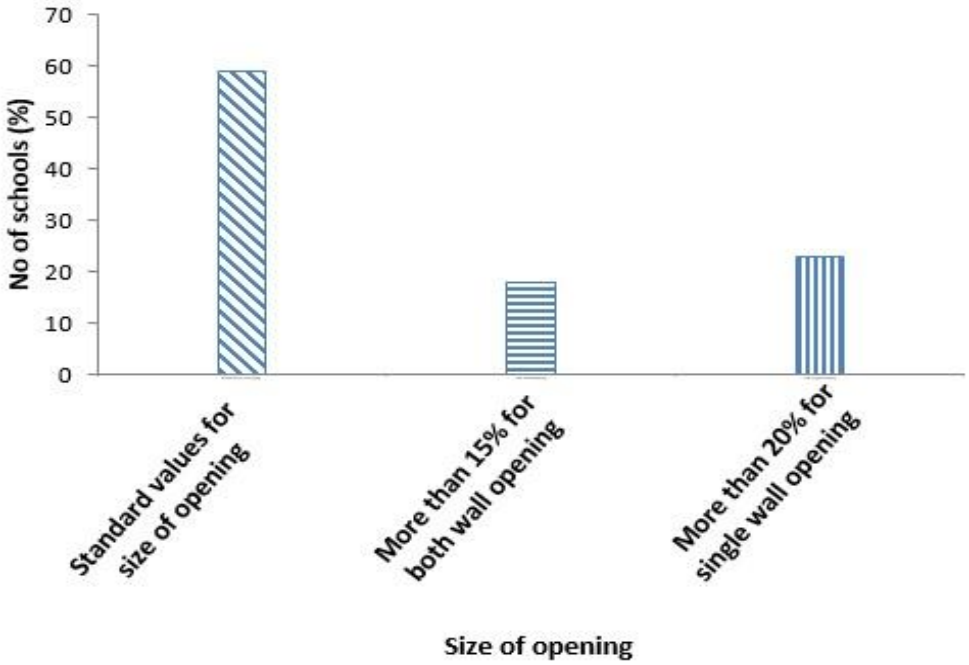
As per IS 4326:1993, the opening % for most of the ground floor buildings were found to be OK.



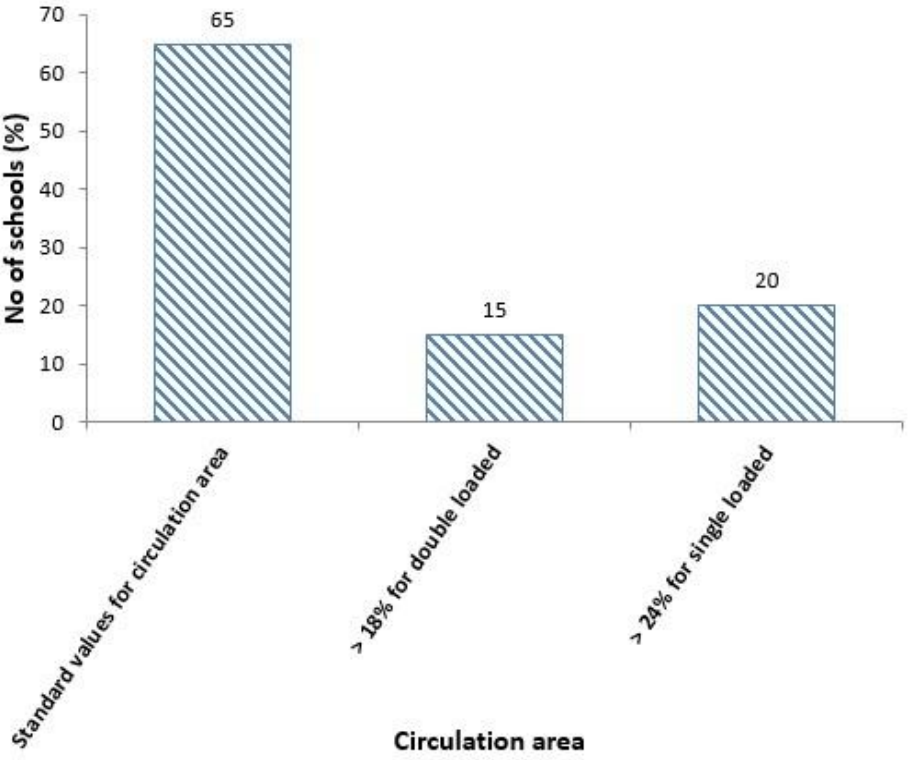
The distance between openings in the school buildings were surveyed and categorized against a safe distance of 2’ as per IS 4326:1993. It was found from the survey that about 40% of the buildings have openings at distance less than 2’ and rest (60%) have openings spaced at more than 2’, which leads us to the conclusion that the brick piers between the openings will be subjected to the shear failure in case of an earthquake.



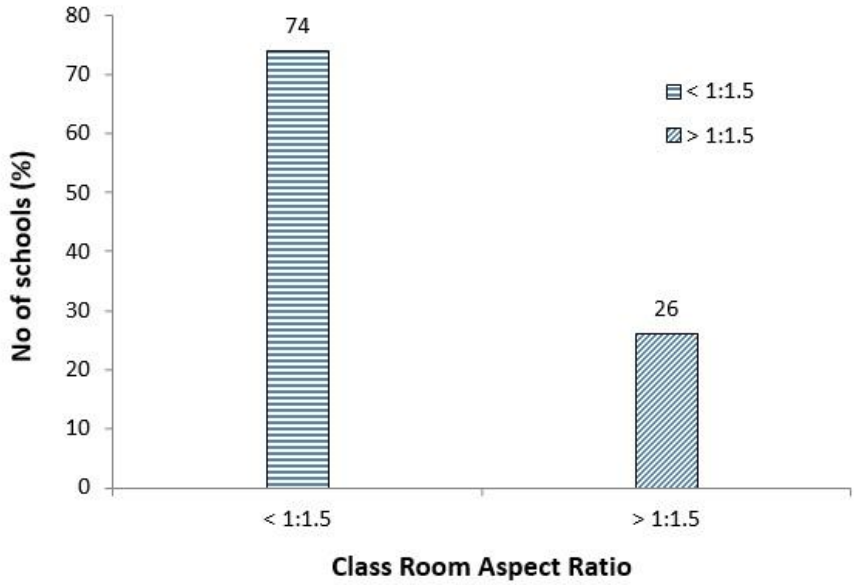
As we know that wall openings have great influence on functioning of the building. Hence the openings were determined against standard safe values according to cl. 4.5.4 of IS 8827:1978. The result showed that 40% of the building openings were not as per the specifications. This could be attributed to improper planning before construction.



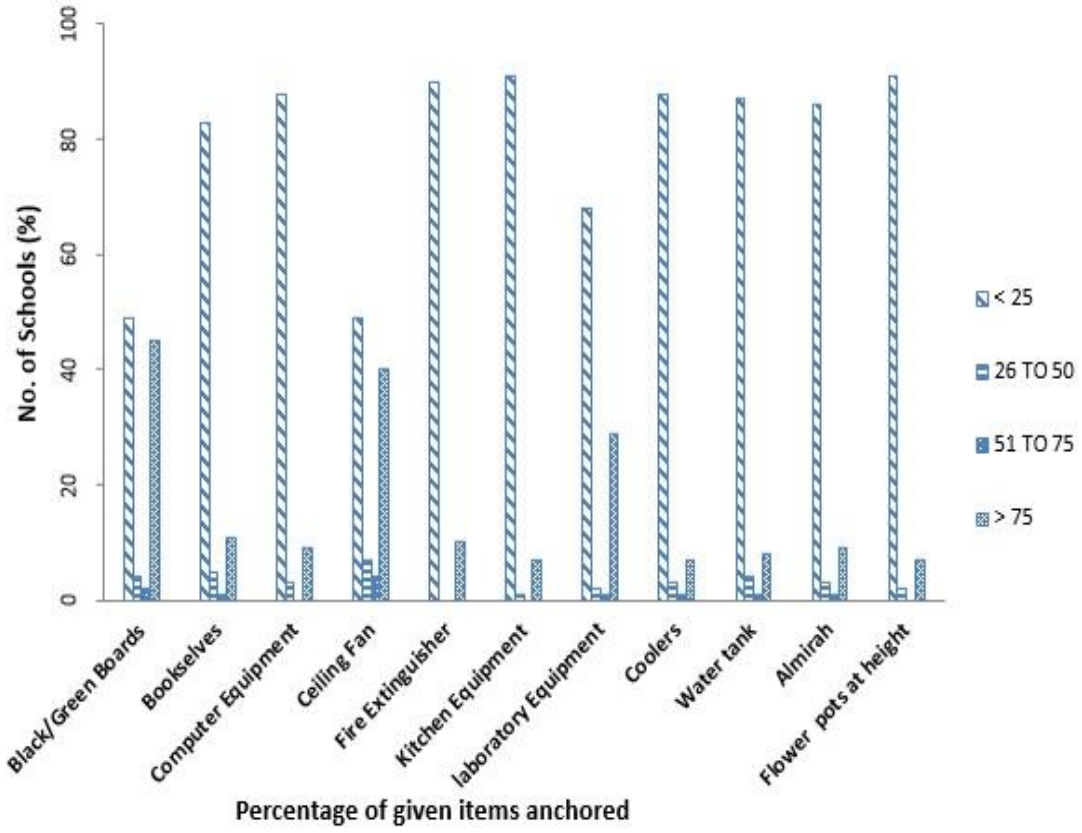
The buildings were surveyed for circulation area as it is directly associated with level of comfort of students as per cl. 9.1 of IS 8827:1978. From the survey data, it was found that about 65% buildings satisfy the standard value of circulation area.



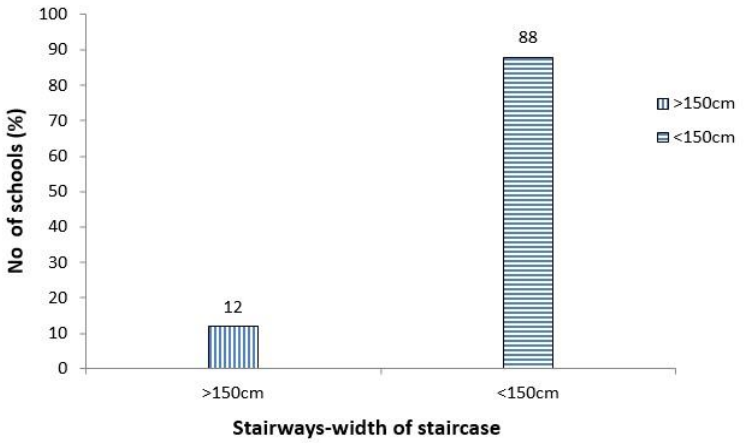
The dimensions of class rooms were surveyed to find out the aspect ratio (too long or too wide classrooms are not recommended as per cl. 4.5.2 of IS 8827:1978). From the survey data, it was found that 74% of school buildings have classrooms less than aspect ratio of 1:1.5, whereas the rest are not as per codal provisions. It is due to improper planning before construction.



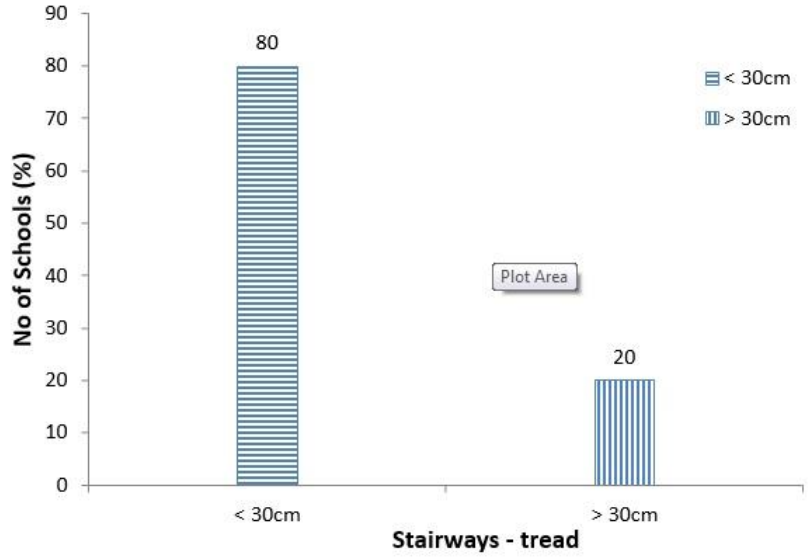
The underwritten non-structural items were surveyed to check the anchorage of the items to the wall/floor as non-anchored items gets damaged during earthquake. From the survey it was found that most buildings have less than 25% non-structural items anchored; hence items like black board, computer equipment, ceiling fan, laboratory equipment, cooler, water tank flower posts are likely to fall and get damaged during earthquake. Therefore the non-structural items are recommended to be anchored to avoid post-earthquake damage expenses.



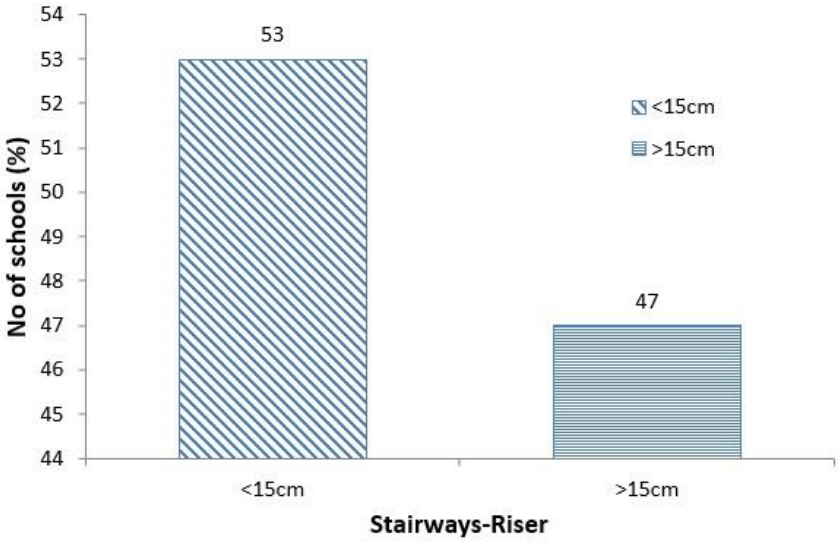
The width of staircases were surveyed to find out whether the stair cases are more than 1.5 meter wide to avoid stampede during hazard as per cl. 9.2.5 of IS 14435:2013. From the survey data, it came out that only 12% buildings have staircase wider than 1.5 meter, rest have narrower staircase. Thus the staircase width are highly deficient with respect to the provisions for fire safety in educational institutions.



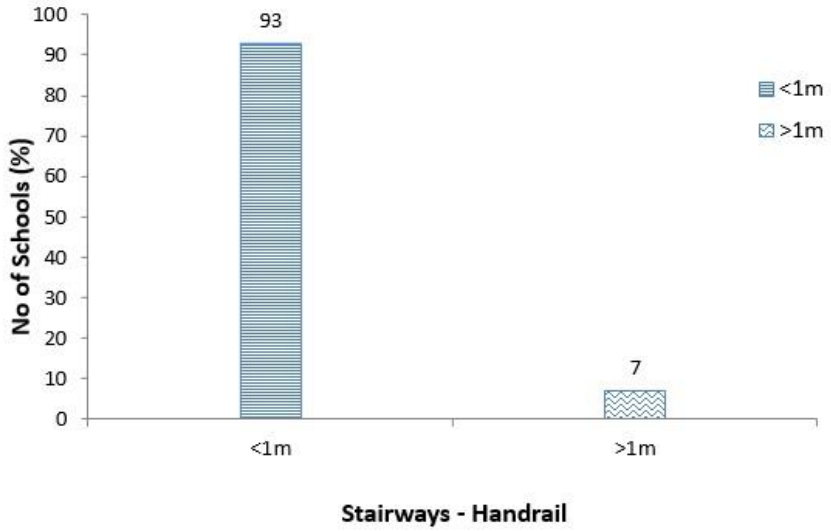
According to IS code, a minimum of 30cm tread is required as per cl. 9.2.6 of IS 14435:2013. From the survey, 80% buildings have tread shorter than 30 cm, whereas only 20% building blocks satisfy the codal provisions for fire safety in educational institutions.



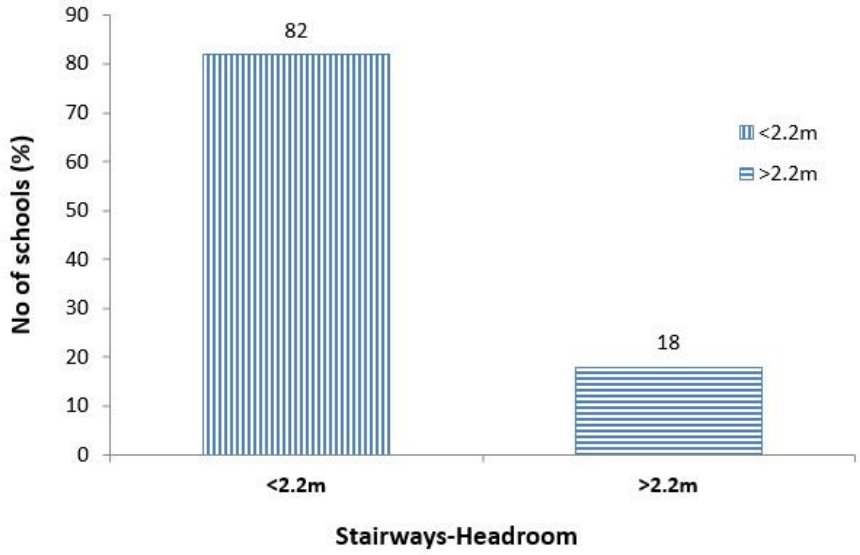
The survey of the parameter of riser in stairways reveal that more than 50% of the school buildings have riser less than 15 cm whereas near to 50% buildings have risers more than 15 cm. Thus the 50% of the staircases in the school building blocks are uncomfortable for use.



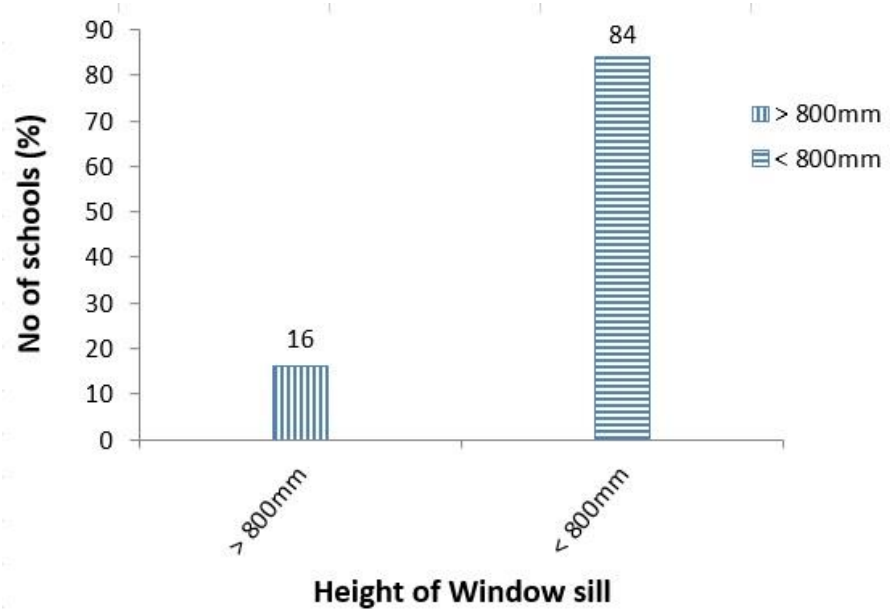
The handrail of stairways was surveyed against a height of 1 meter. From the survey it was found that 93% school buildings have stairways having handrail shorter than 1 meter, whereas only 7% buildings have handrails higher than 1 m. Hence it can be concluded that the stairways do not have proper height of handrails.



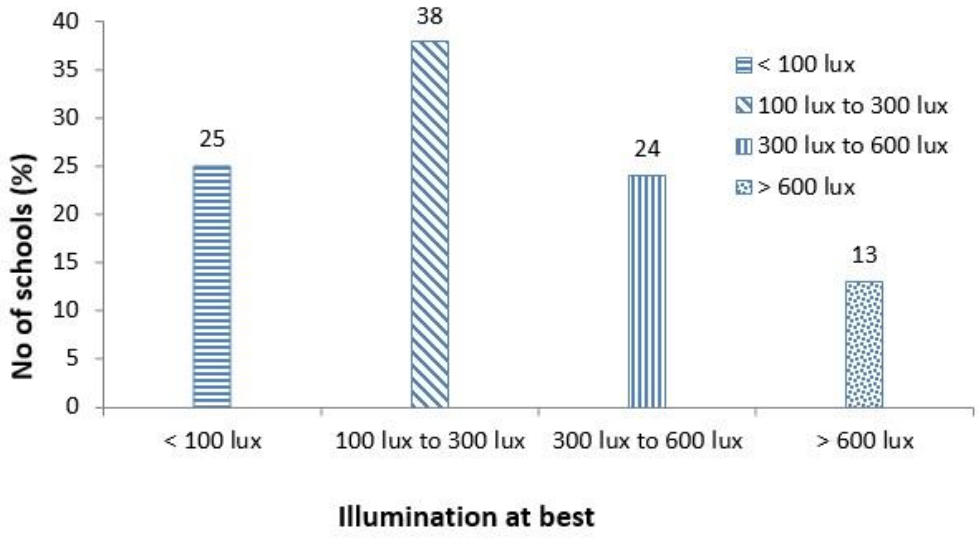
The stairway headroom should be high enough to provide clearance height for a person. Hence the headroom of stairways were measured against a safe height of 2.2 meter. However, it seems that this is discrepancy in survey data due to incorrect input by the surveyors.



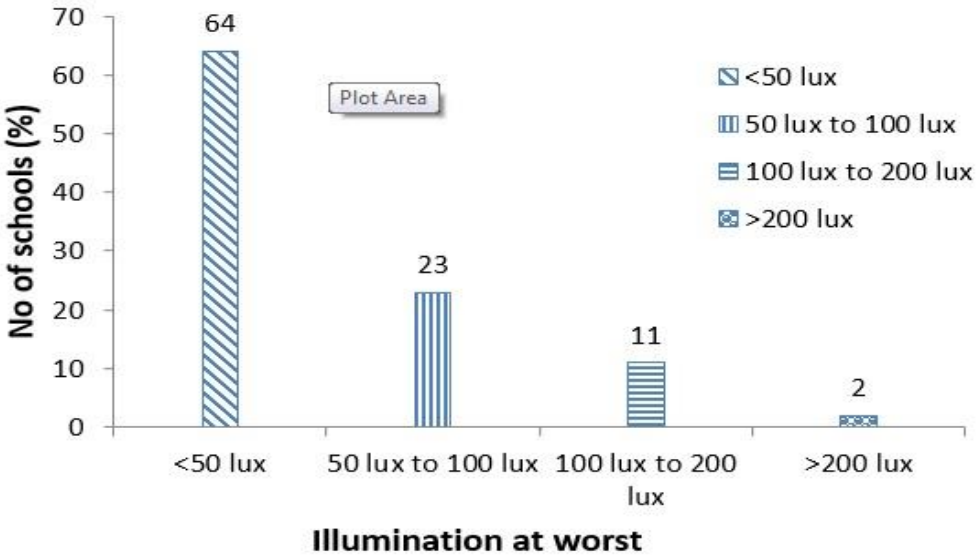
According to cl. 4.5.3 of IS 8827:1978, height of window sill for classrooms with furniture should be <800 mm. From the survey data, 84% buildings were found to be as per the codal provision.



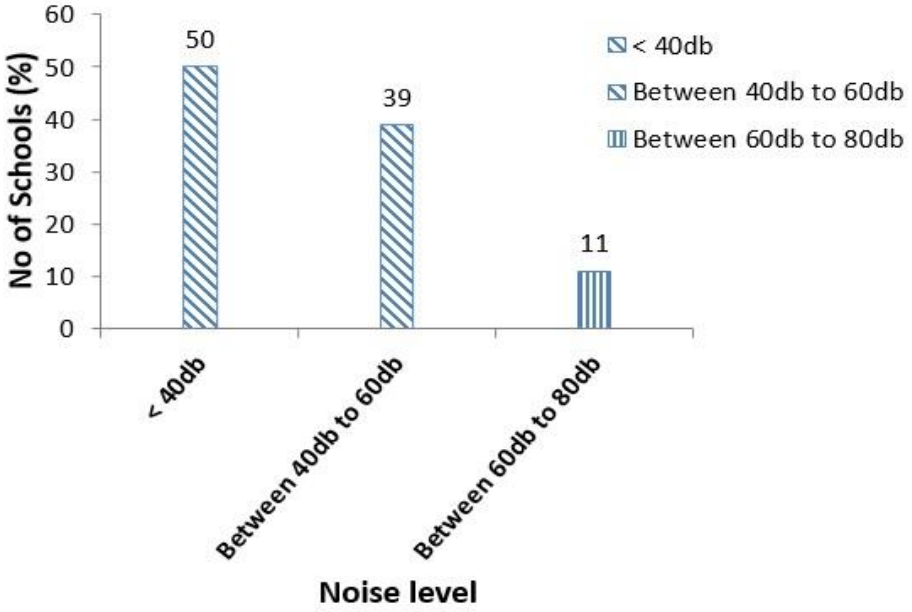
According to table 5 of IS 8827:1978, illumination at classroom desk tops should be 150-300 lux. Hence the classrooms were checked for illumination at best. From the survey, it came out that 25% buildings do not have even illumination of 100 lux which is less than the minimum requirement of the classroom.



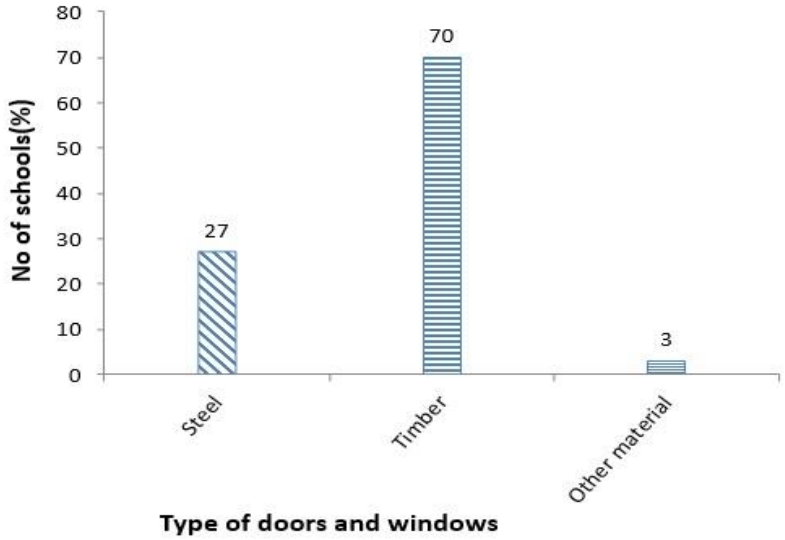
The classrooms were also checked for illumination at worst, which was checked against the minimum requirement of illumination of 150 lux according to codal provisions. From the survey, it can be concluded that about 87% schools have classrooms less than 100 lux illumination, which is a big issue about comfort of students during classes.



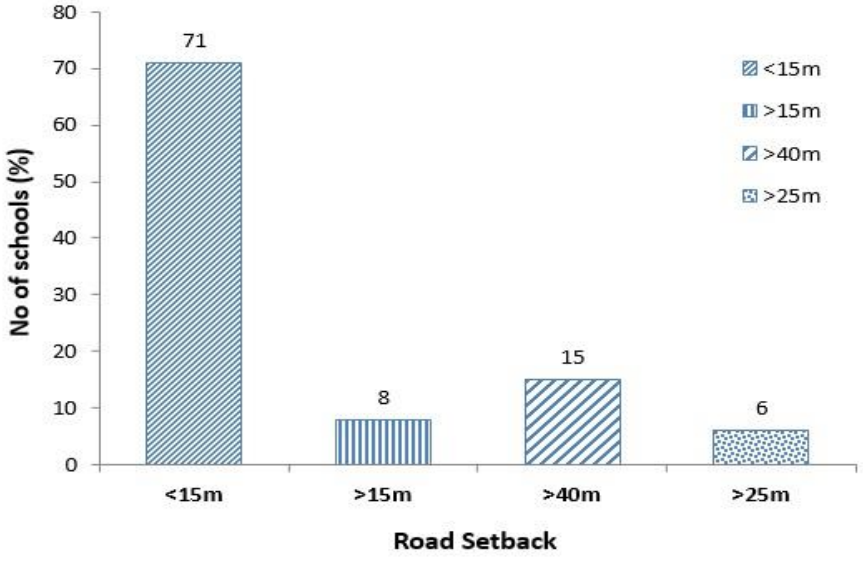
The noise level in the school buildings were surveyed as per cl. 6.2 of IS 8827:1978. From the survey report, it was found that only half of the classrooms in building blocks satisfy the noise level of less than 40 dB.



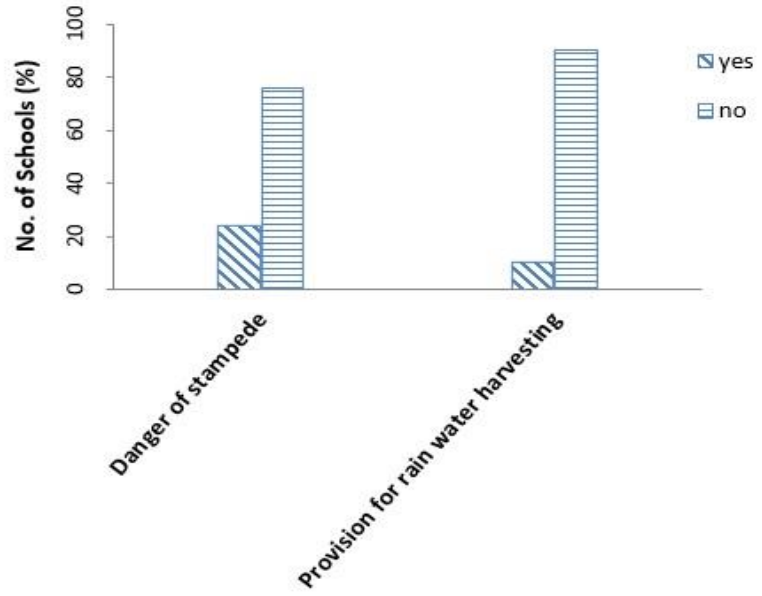
The material constitution of door and windows in classrooms were surveyed. According to the survey data, timber and steel were used as material in 70% and 27% cases respectively.



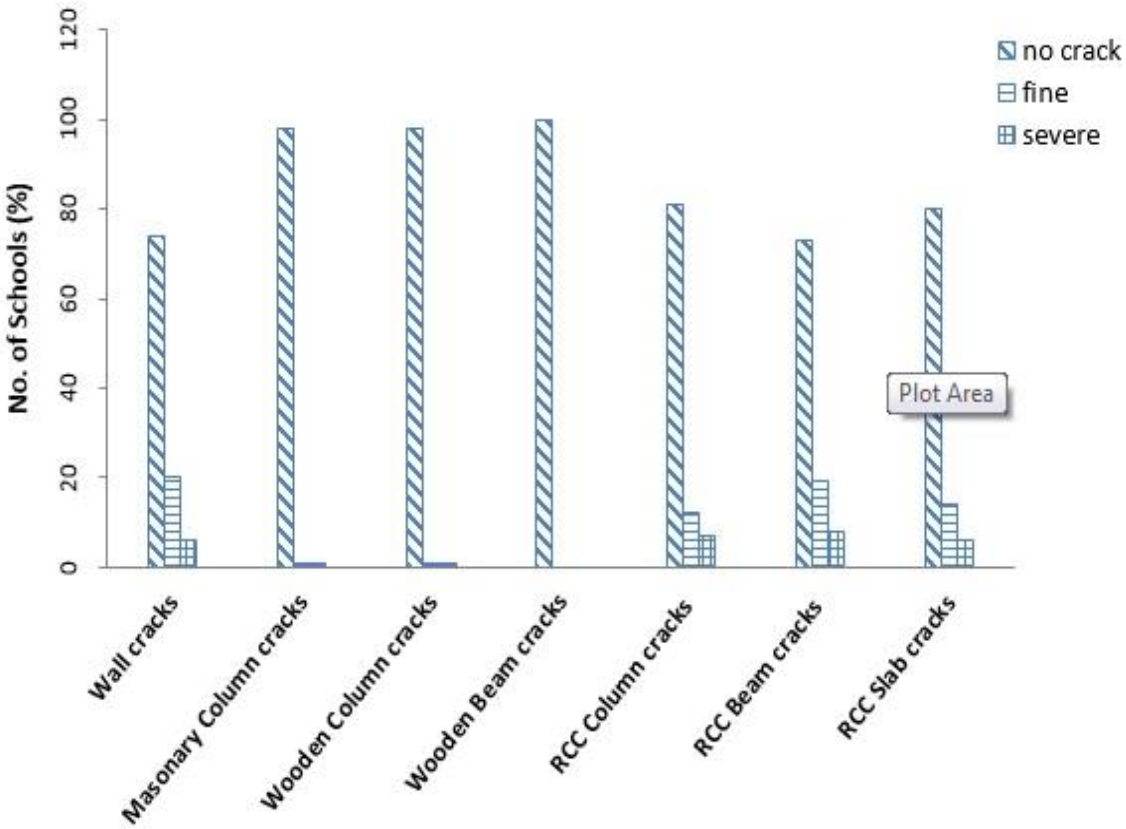
The school building blocks were surveyed for road setback. From the survey data, it was found that 71% buildings have road setback of less than 15 m.

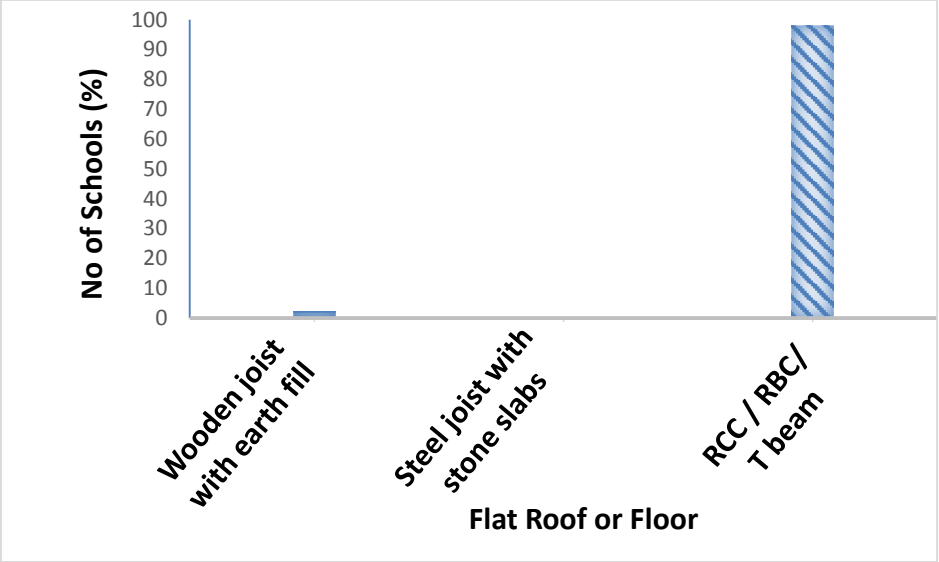


The following parameters were surveyed in school buildings. It has been found that 20% buildings has danger of stampede, due to non-coverage of staircase from top; whereas in 90% buildings provision for rain water harvesting is not present.

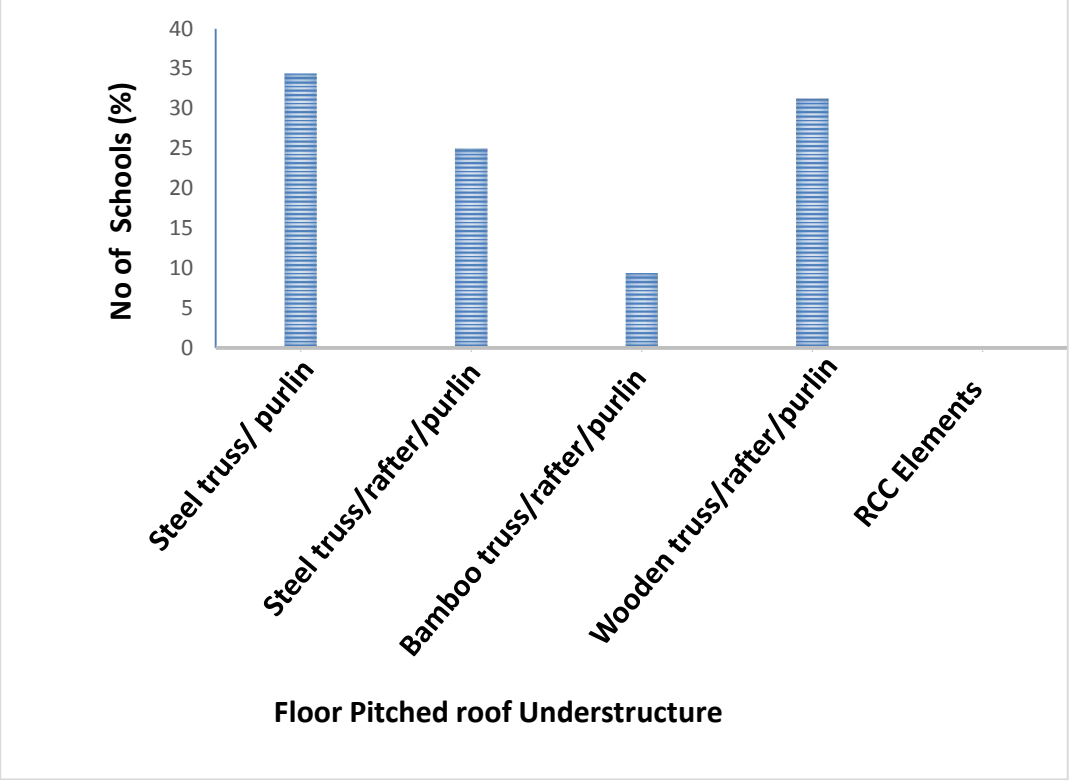


The school building blocks were surveyed to find out cracks on structural members. From the survey data, it was found that most of the buildings are structurally stable.

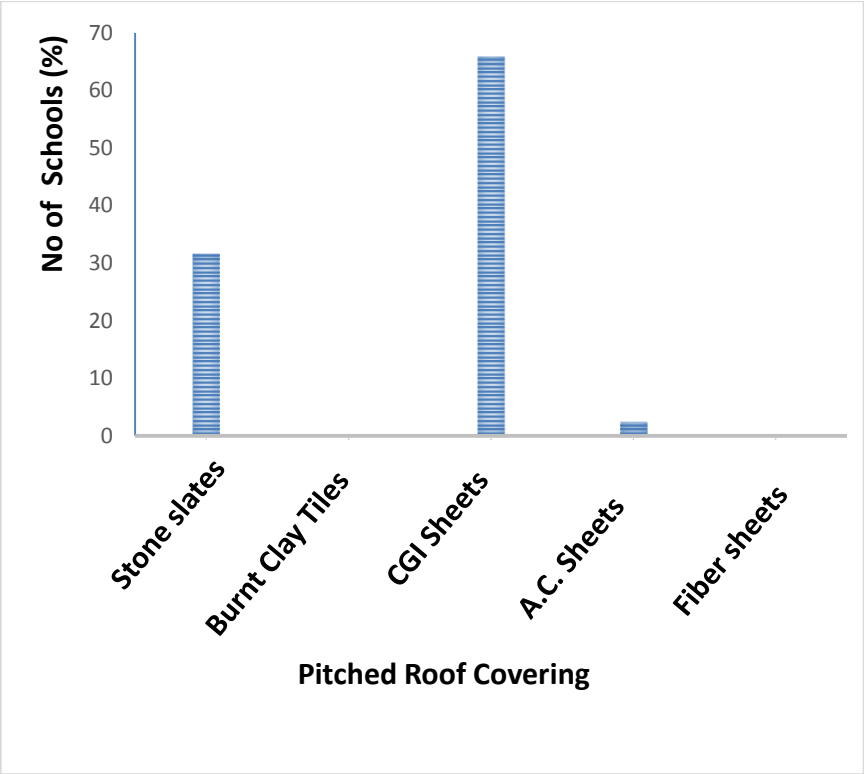




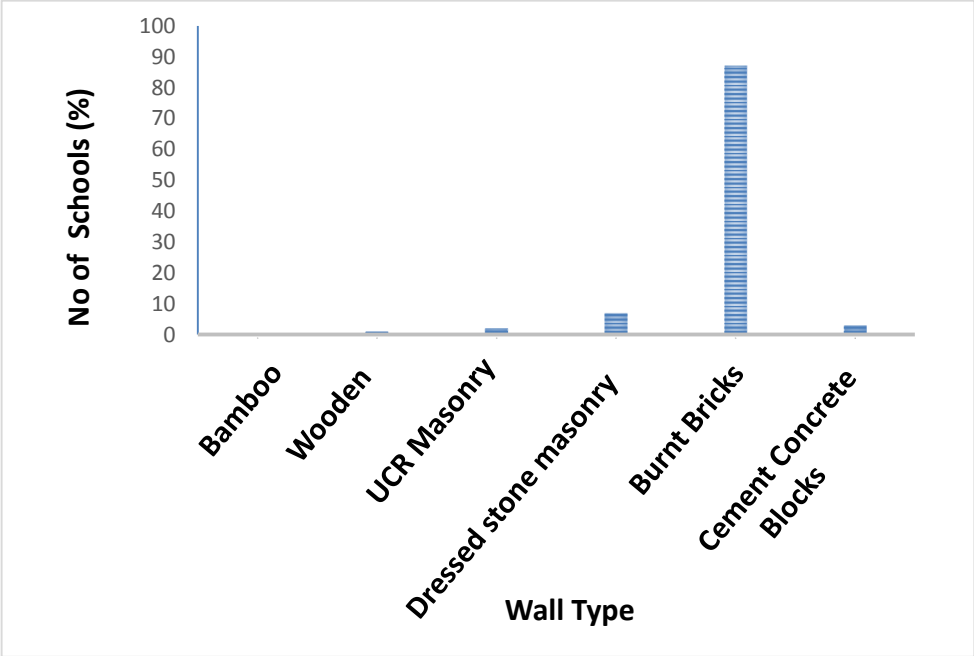
The pitched roof materials were surveyed in school building blocks. It was found that steel has been used in most cases in the forms of truss, rafter or purlin; whereas in rest of the cases wood is used as roof material.



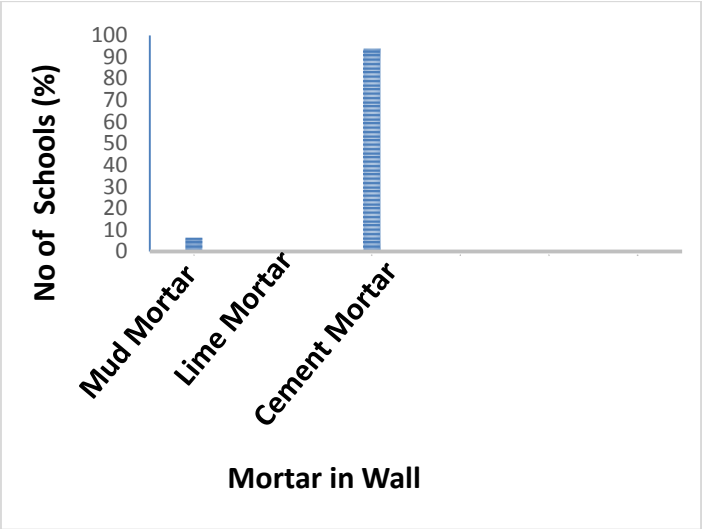
The material of roofs in school buildings were surveyed. From the survey report, it was found that CGI sheet or stone slates have been used as roof materials in most cases.



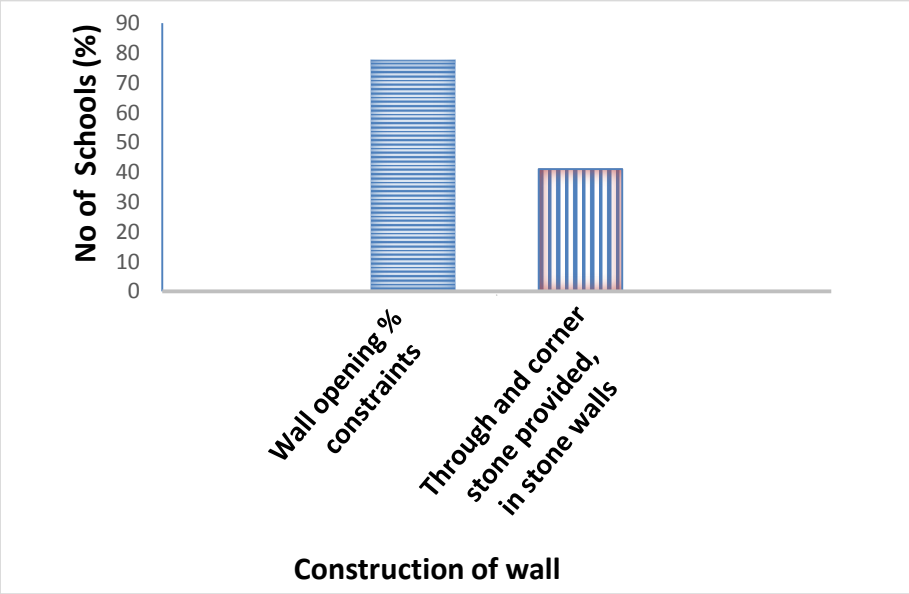
The wall material were also surveyed. From the survey data, burnt brick was found to be most commonly used material for construction of walls.



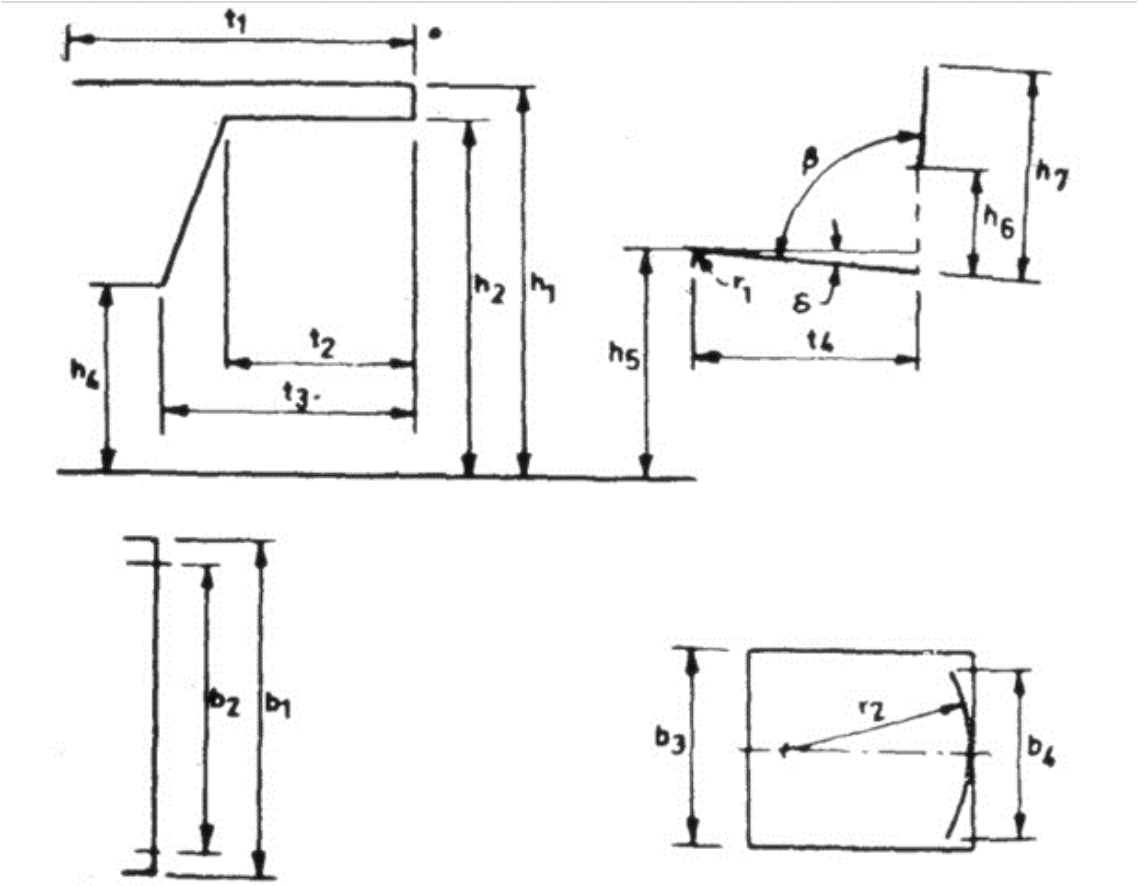
The masonry building wall mortars were surveyed which reflected the use of cement mortar as commonly used material in walls.



The following parameters were surveyed in school building blocks. From the survey report, it was found that 75% school building blocks have wall opening % constraints and 40% buildings have through and corner stone provided in case of stone walls.



17. Table and chair dimension guidelines for schools according to IS 4837:1990



		Size mark	1 (as per code)	1 (as per manufac turers)	2 (as per code)	2 (as per manufac turers)	3 (as per code)	3 (as per manufac turers)	4 (as per code)	4 (as per manufac turers)	(as in schools) G/B
Seat	h_5	Height of seat	260+3	--	300+3	300	340+3	380	380+3	450	400/450
	t_4	Effective depth of seat	250 - 270	240	280 - 300	240	320 - 340	240	350 - 370	240	240/220
	b_3	Min. width of seat	250		300		320		380		450/500
	r_1	Radius of front of seat	30 – 40		30 - 40		30 - 40		30 - 40		240/220
	δ	Max. angle of seat	4°		4°		4°		4°		0°
Backrest	β	Angle between seat and backrest	95° - 100°		95° - 100°		95° - 100°		95° - 100°		90°/90°
	h_6	Seat plane to bottom of backrest	110 – 120		120 - 130		140 - 150		150 - 160		175/175
	h_7	Seat plane to top of backrest	210 – 250		250 - 280		280 - 310		310 - 330		350/350
	b_4	Min. width of backrest	250		250		250		280		240/300
Tables	h_1	Height of top	460+3	--	520+3	610	580+3	690	640+3	760	750/750
	t_1	Min. depth of top	450	--	450	300	450	300	450	300	380/300
	b_1	Min. 1 place length	450		450		450		450		910/910
		of top 2 place	1050	--	1050	900	1050	900	1050	900	
Leg Clearance	t_2	Min. depth of knee zone	300		300		300		350		350/350
	t_3	Min. depth of tibia zone	400		400		400		450		
	h_2	Min. height of knee zone	400		460		520		580		400/450
	h_4	Min. height of tibia zone	250		250		300		300		

18. Correct and Incorrect practices

Design practice only

The construction of school buildings should be carried out in accordance with the recommendations given in IS 8827:1978. The orientation of buildings should be carried out in accordance with the recommendations given in IS 7662(Part 1):1974.

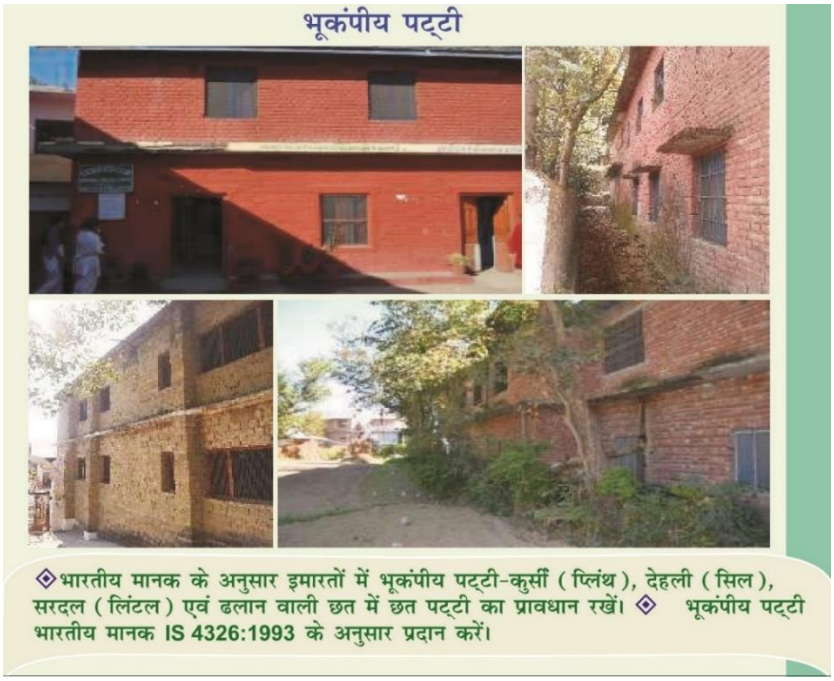
Length-to-width ratio of classrooms should not be greater than 1.5. The plan of classrooms should be in accordance with the recommendations given in IS 8827:1978 and the furnitures in classrooms should be in accordance with the recommendations given in IS 4837:1990.

Design practice only

There should be provision for plinth protection and proper drainage in school buildings. Construction of walls should be in accordance with the recommendations given IS 1127:1970 and IS 1597 (Part 2):1992.

Symmetrical building plan design should be adopted. Earthquake resistant bands should be provided. Building Design should be done in accordance with Indian Standard code for earthquake resistant design IS 1893:2002.

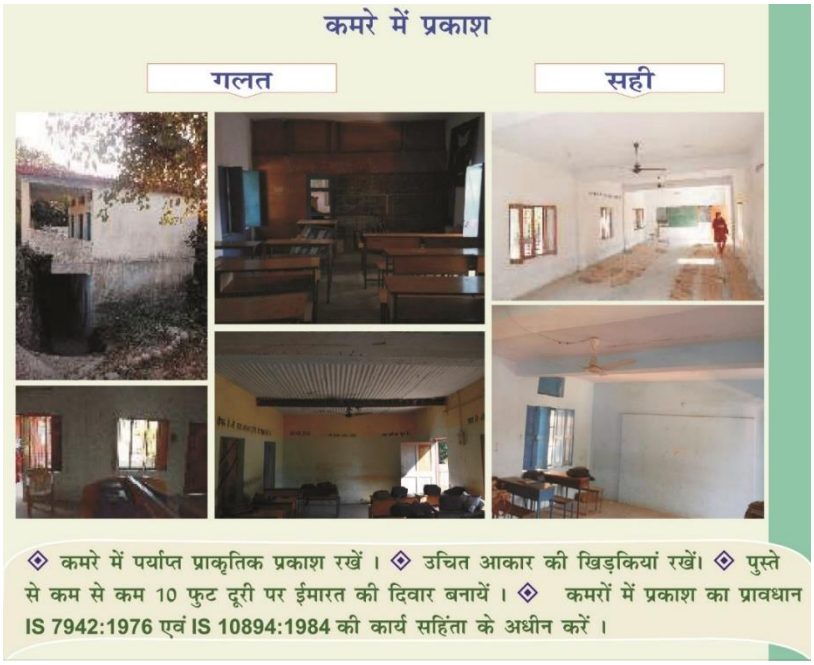
Design practice only



Plinth band, lintel band, sill band and roof band for sloping roofs should be provided to improve performance of a building under the effect of earthquake. Earthquake resistant bands should be provided in accordance with IS 4326:1993.

The tread and riser for stairs should be 30cm and 15cm respectively according to Indian standards. Railing should be provided in stairs for safety. The provision for fire safety of stairs should be in accordance with the code of practice IS 14435:2013.

Design practice only

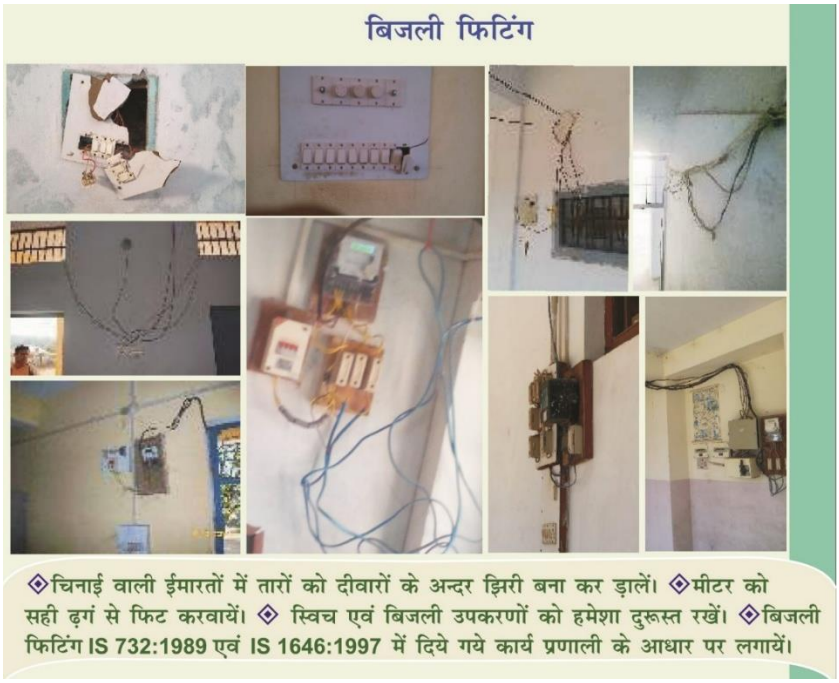


There should be proper illumination at classrooms (at least 150 lux for students' comfort). Adequate window opening should be provided. The distance of classrooms from retaining wall should be at least 10ft for proper illumination in classrooms. The illumination in the classrooms should be kept in accordance with IS 7942:1976 and IS 10894:1984.

The distance of classrooms from retaining wall should be at least 10' for adequate illumination in the classrooms. The height of sill level should be 2ft in classrooms without table and chair and 2.5ft in classrooms with table and chair. The construction of retaining wall should be in accordance with IS: 14458(Part 1):1998.

Construction practice only

Windows and doors should be provided with hinges such that it does not cause any obstruction to the passageways. Selection, installation and maintenance of timber doors and windows should be in accordance with IS 4913:1968.



In case of buildings with brick walls the installation of electric wiring should be done by providing slit in walls. Installation of meter should be done properly. Switches and other electric installations should be regularly maintained. Electrical wiring installations should be in accordance with IS 732:1989 and IS 1646:1997.

Construction practice only

Almirahs should be attached to walls and floors to avoid damage due to earthquake.

Flooring should be done by making rectangular divisions. Adequate curing of concrete should be done at initial stage. Cement, sand and water should be used in correct proportions. The ratio of cement to sand should not be greater than 1:4. Laying In-Situ Cement Concrete Flooring should be in accordance with IS 2571:1970.

Construction practice only

Brick wall should be constructed after shrinkage of lintel beam. The brick wall above lintel level should be constructed at least after 14 days of construction of lintel. To prevent cracks in building SP:25-1984 should be referred.

Expansion and contraction joints should be provided wherever necessary. Gap should be maintained between RCC beam/column and Wall. To prevent cracks in building SP:25-1984 should be referred.

Construction practice only

Gap between beam and wall should be maintained. This gap should be filled with rich mortar. To prevent cracks in building SP:25-1984 should be referred.

A minimum reinforcement cover of 20mm should be provided in beams. Beams should be protected from dampness. The thickness of plaster should be around 15mm. Design of beams should be in accordance with IS 456:2000.

Construction practice only

Plinth protection should be provided. Damp Proofing Course (DPC) should be provided at plinth level. Construction of wall should be according to the code of practice IS 2212:1991.

Toilet seat should be properly connected to waste pipe. To protect toilets from dampness, the recommendations given in IS 13182:1991 should be followed.

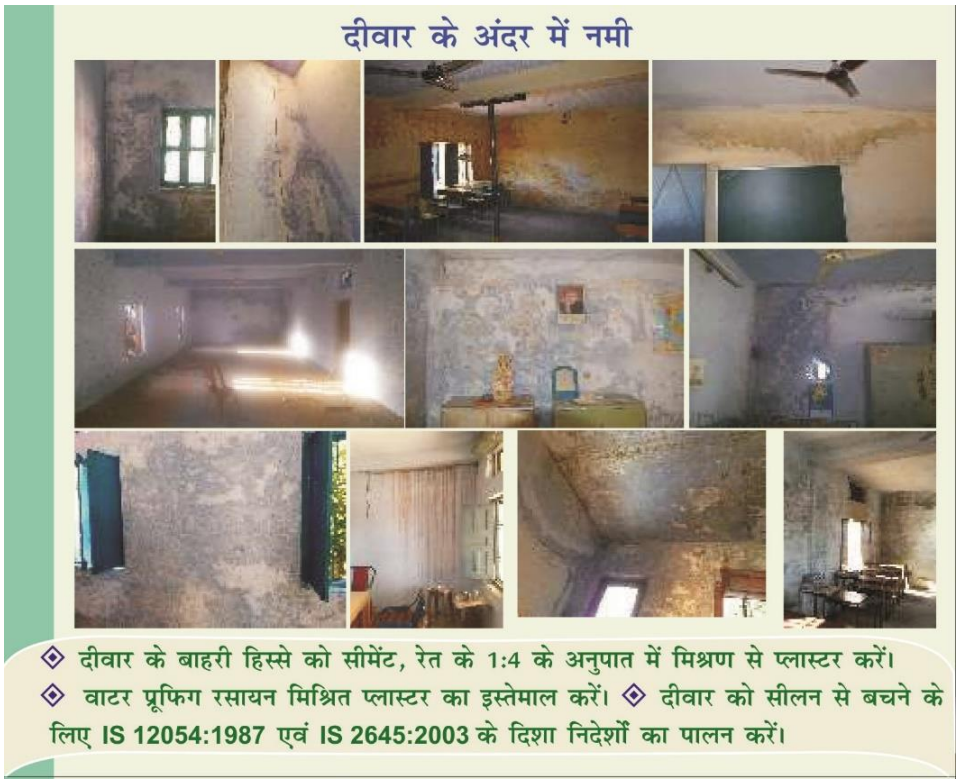
Construction practice only

Provide appropriate slope for the drains. Always provide drains for water flow. Provide water drain 1.5ft away from the wall. Water drains should be provided in accordance with code of practice IS 1742:1983 and IS 2527:1984.

Provide Tap at appropriate distance from the wall. Taps should be always properly maintained. The water supply should be in accordance with the code of practice IS 2065:1983 and IS 6295:1986.

Two buildings should be separated by at least 2 inches. The gap between the buildings should be filled with Sealant. The code of practice IS 4326:1993 and IS 3414:1968 should be followed for building separation joints.

Provide beams under slab to impart adequate stiffness. Provide adequate thickness to the slab. Before laying slab provide smooth plaster with bitumen coat / tar coal paper on the wall edge.



The outer side of the wall should be plastered with cement-sand ratio of 1:4. Use plaster mixed with waterproof chemical mixture. To prevent dampness in the wall the code of practice of IS 12054:1987 and specifications given in IS 2645:2003 should be followed.

The plastering and waterproofing of RCC roof should be carried out. Provide proper slope to the roof. Water drain should be kept clean. Follow IS 3067:1988 to prevent dampness in the roof.

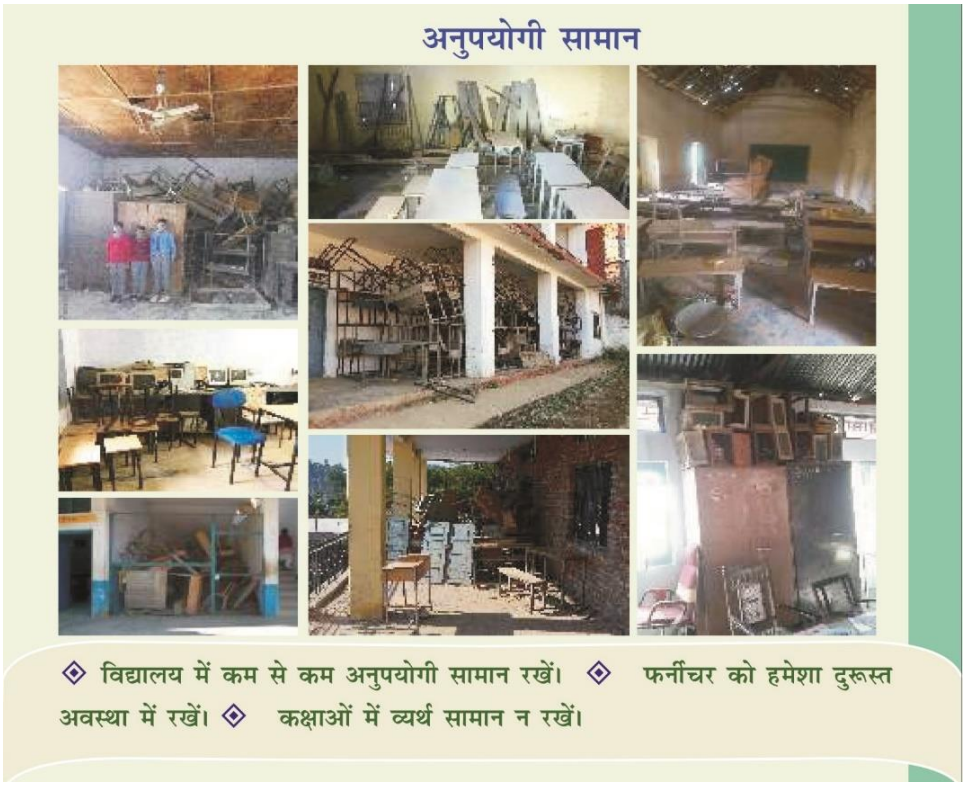
Construction practice and Construction quality

The cement, sand and water should be mixed in correct proportion. Scratch the first plaster layer before applying the second layer. Before plastering, curing of the wall should be carried out. Plastering should be carried out in accordance with code of practice of IS 1661:1972, IS 2116:1980 and IS 2250:1981.

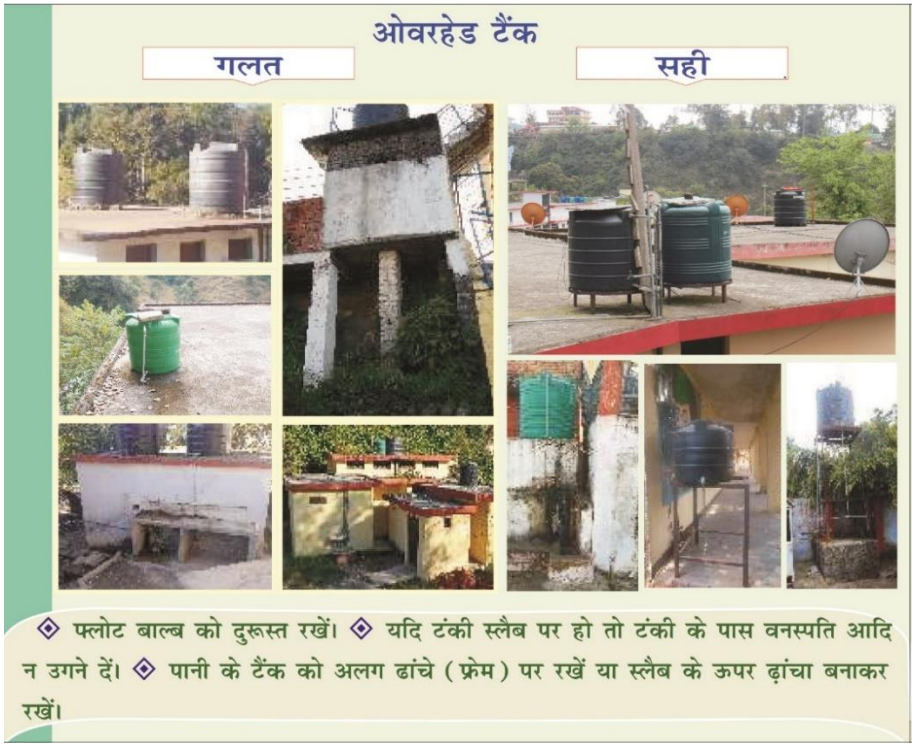
Design Practice, Construction Practice and Construction Quality

As per Indian standard, minimum 15mm cover should be provided in the slab. Slope of the slab should be firm not porous. To prevent rusting of reinforcement follow code of practice IS 9077:1979.

Bad practice



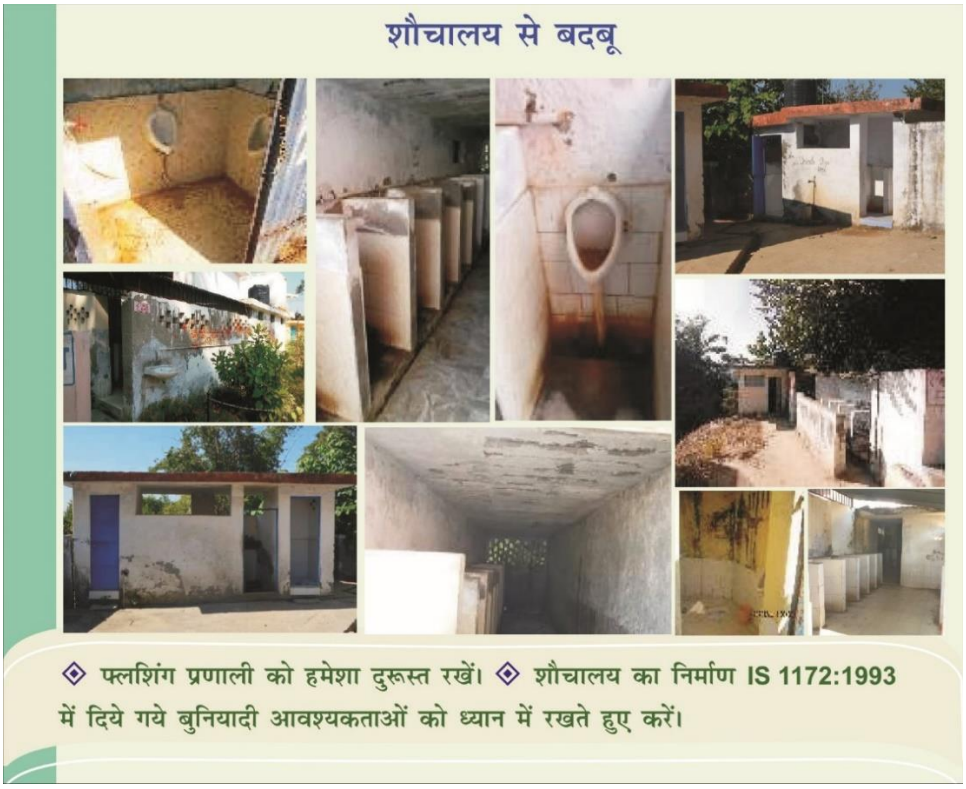
In schools, unusable items should be as minimum as possible. Furniture should always be in workable condition. Do not keep useless things in the classrooms.



Keep float valve in working condition. If water tank is on the slab, prevent the growth of vegetation around it. Keep water tank on separate frame or construct separate frame for the tank.

Bad practice

Always hang fans using fan box under slab.



Flushing system should always be in working condition. Toilet should be constructed based on the basic requirements of IS 1172:1993.

Bibliography

1. IS 456:2000 -- Plain and reinforced concrete - code of practice.

2. IS 732:1989 (Reaffirmed 2005) -- Code of practice for electrical wiring installations.

3. IS 1127:1970 (Reaffirmed 2003) -- Recommendations for dimensions and workmanship of natural building stones for masonry work.

4. IS 1172:1993 (Reaffirmed 2002) -- Code of basic requirements for water supply, drainage and sanitation.

5. IS 1597(Part 2):1992 -- Construction of stone masonry - code of practice: Part 2 Ashlar masonry.

6. IS 1646:1997 -- Code of practice for fire safety of buildings (general): Electrical installations.

7. IS 1661:1972 (Reaffirmed 2001) -- Code of practice for application of cement and cement-lime plaster finishes.

8. IS 1742:1983 (Reaffirmed 2002) -- Code of practice for building drainage.

9. IS 1893(Part 1):2002 -- Criteria for earthquake resistant design of structures: Part 1 General provisions and buildings.

10. IS 1905:1987 (Reaffirmed 2002) -- Code of practice for structural use of unreinforced masonry.

11. IS 2065:1983 (Reaffirmed 2001) -- Code of practice for water supply in buildings.

12. IS 2116:1980 (Reaffirmed 2002) -- Specification for sand for masonry mortars.

13. IS 2212:1991 (Reaffirmed 2005) -- Brickworks - Code of practice.

14. IS 2250:1981 (Reaffirmed 1995) -- Code of practice for preparation and use of masonry mortars.

15. IS 2527:1984 (Reaffirmed 2000) -- Code of practice for fixing rainwater gutters and downpipes for roof drainage.

16. IS 2571:1970 (Reaffirmed 2001) -- Code of practice for laying in-situ cement concrete flooring.

17. IS 2645:2003 (Reaffirmed 2005) -- integral waterproofing compounds for cement mortar and concrete - Specification.

18. IS 3067:1988 (Reaffirmed 2000) -- Code of practice for general design details and preparatory work for damp-proofing and water-proofing of buildings.

19. IS 3414:1968 (Reaffirmed 2000) -- Code of practice for design and installation of joints in buildings.

20. IS 4326:1993 (Reaffirmed 2003) -- Earthquake resistant design and construction of buildings-code of practice.

21. IS 4837:1990 (Reaffirmed 2002) -- School furniture, classroom chairs and tables - Recommendations.

22. IS 4913:1968 (Reaffirmed 1996) -- Code of practice for selection, installation and maintenance of timber doors and windows.

23. IS 6295:1986 (Reaffirmed 2001) -- Code of practice for water supply and drainage in high altitudes and/or sub-zero temperature regions.

24. IS 7662(Part 1):1974 (Reaffirmed 2004) -- recommendations for orientation of buildings: Part 1 Non-industrial buildings.

25. IS 7942:1976 (Reaffirmed 2004) -- Code of practice for daylighting of educational buildings.

26. IS 8225:1987/ISO 354:1985 (Reaffirmed 2002) -- Measurement of sound absorption in a reverberation room.

27. IS 8827:1978 (Reaffirmed 2006) -- Recommendations for basic requirements of school buildings.

28. IS 9077:1979 (Reaffirmed 2002) -- Code of practice for corrosion protection of steel reinforcement in RB and RCC construction.

29. IS 10894:1984 (Reaffirmed 2005) -- Code of practice for lighting of educational institutions.

30. IS 12054:1987 (Reaffirmed 2002) -- Code of practice for application of silicone-based water repellents.

31. IS 12183(Part 1):1987 (Reaffirmed 2004) -- Code of practice for plumbing in multistoreyed buildings: Part 1 Water supply.

32. IS 13182:1991 (Reaffirmed 2000) -- Waterproofing and damp-proofing of wet areas in building recommendations.

33. IS 14435:1997 (Reaffirmed 2002) -- Fire safety in educational institutions - Code of practice.

34. IS 14458(Part 2):1997 (Reaffirmed 2002) -- Retaining wall for hill area: Part 2 Design of retaining / breast walls.

35. SP:25-1984 -- Handbook on causes and prevention of cracks in buildings.