NEPAL-RASUWA-THUMAN
Rebuilding project of the school
Earthquake resistant

Recipient : Project owner, department in charge of the implementation of the project.

This document contents :

Report :	**Technical drawning :**
• *Description of Thuman village,* • *Imput data,* • *Features of the old school,* • *Description of the need,* • *Design presentation,* • *Nepal national Building Code (NBC) justification,* • *Estmate cost,* • *Schedule,*	• *Draft : plan view,* • *Classroom : 3D views,* • *Classroom : Front & side view,* • *Classroom : Cross section,* • *Store & bathroom : 3D views,* • *Store & bathroom : Front & side view,* • *Store & bathroom : Cross section,*
This parts contents 12 pages,	*This parts contents 14 feals,*

Description of Thuman village

Localisation : Népal – District : Rasuwa – Village : Thuman,

The region is located 120km north of Katmandou,

Population : 850,

School and education:

One governement school from 1 till class 8 with a total of 108 students before the earthquake and 63 students after the earthquake. There are 8 teachers and a headmaster. The location of the school is over of the village (travel time 15 min). The school is destroyed and a temporary school was rebuilt.

Economic development :

- Farming,
- Tourism : the Trek « Tamang Heritage Trail » across the village,

Electrical network : available,

Altitude : 2 400m,

Geography : South-east orientation wtih steep slopes,

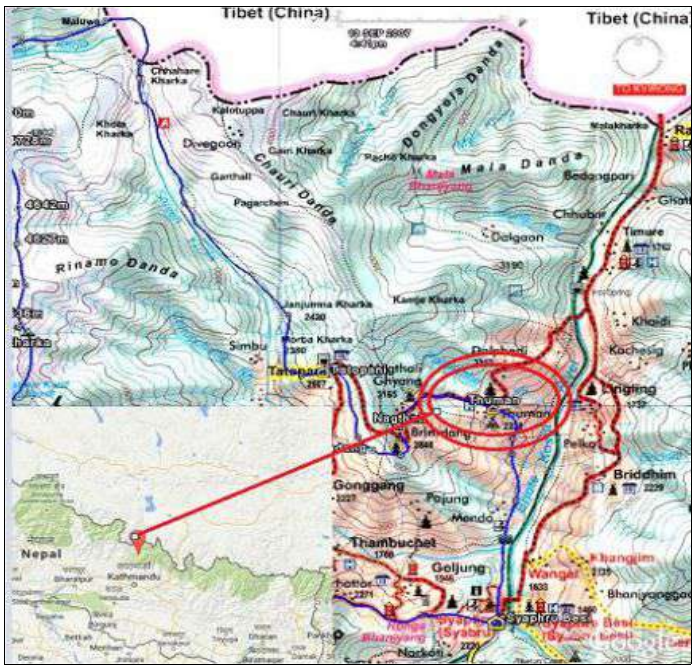
Topography : 20% slope on agricultural terrace,

Geology : The soil is composed of :

- 70 % Sand (the quality is interesting for the achieve walls coatings),
- 30 % Shale block scree (1till 10 to per rocks),

Hydraulic : A water source is located 1km over the village (south border),

Flora : The dry soil allows the growth of some thorny tree. Over 2700m altitude the forest is available with the presence of timber.



Geography

Imput data

Due to the lack of platform available over a minimum area of 500 m² (4500 sq ft) near the village, the project is to rebuild the school on the old location. Currently, a temporary school was built on the old playground.

No. studients before the earthquake : 108,

No. studients after the earthquake : 63,

No. Teacher avalaible : 8,

Local materials from the old schhol available :

- Stone : 130 m3 (3 510 ft3) of cut stone shale. Medium quality but enough for the masonry
  - 70% ready tu use,
  - 30% avalaible in the old wall (waiting for demolition).
- Wood : 350 ml (1150 ft) of old wood beam. Medium quality but possibly reuse for the door and windows frame :
- CGI sheet : 87 m² (963 sq ft) (Medium quality).

Features of the old school

The old school was composed :

- 8 classrooms :
  - Lengt : 4,30 m (13,12 ft),
  - width : 3,70 m (9,84 ft),
  - Area : 15,91 m² (161,45 sq ft),
- 1 office :
  - Lengt : 7,10 m (22,90 ft),
  - width : 5,10 m (16,40 ft),
  - Area: 36,21 m² (387,50 sq ft),
- 2 bathrooms (20m²x2 = 40 m²- 430 sq ft),

The total area of the old school is 200 m² (2 152 sq ft).

Overview site

The need

- Earthquake resistance,
- Same aspect,
- Electric installation,
- Sanitary installation,
- Roof resistant to weight of snow,
- For upkeep reasons : priority masonry stone instead of wood,
- Number de rooms :
  - No. classroom : 8,
  - No. office 2,
  - No. bathroom : 2
  - No. store : 1, **Tot = 13 rooms**

Design presentation

Architectural design :

The school is composed of 6 buildings on one storey (outside size : 8,75 x 6,4m – 28,7 x 21ft). The network electrical & sanitary is included. The building are separated by a distance of 1.5m.

- Classroom : 4 buildings with each 2 classrooms (area per classroom : 20,35m² – 215 sq ft),
- Office : 1 building with 2 rooms (area per room : 20,35m² – 215 sq ft),
- 1 buillding for the store and bathroom, with 3 rooms :
  - store : 1 room (area : 20,35m² – 215 sq ft),
  - bathroom/toilet : 2 rooms with each 4 toilets and 2 wash basins (area per room : 20,35m² – 215 sq ft),

The total area of the 264,55 m² – 2 846 sq ft (total area of the old school : 200 m² - 2 152 sq ft),

Incread area : + 30 %.

Outside design :

- Stone masonry mud wall with cement/lime joint,
- The roof slope : 27 °-2/1,
- CGI-sheet roof with glass opening,
- Wood doors and windows,

Inside design :

- Flooring in concrete topping ,
- Plywood partition against the wood truss located between the rooms,
- Truss and diagonal bracing in timber,
- Walls coatings mixed Earth-cement or lime (optional),

Earthquake resistance design :

The village is not accessible by road. So, the local materials are privileged. Following comparative studies, it was found that the presence of reinforced concrete significantly increases the cost of transportation.

To optimize the cost of the project, it was decided to first use the materials available on site, namely wood and stone.

Each building is composed by :

- Fundation in reinforced concrete,
- Reinforcement horizontale timber bands in the wall (plinth, sill, stitch, linter, roof ang gabbler band = 6 horinzontale bands),
- Reinforcement vertical timber in each corner and jonction wall,
- Reinforcement vetical steel in each corner and jonction wall,
- Bracing roof in wood,

Nepal national Building Code (NBC) justification

Document references for the study are:

Nepal national buiding code :

- *NBC 101 : MATERIALS SPECIFICATIONS ,*
- *NBC 106 : SNOW LOAD,*
- *NBC 108 : SITE CONSIDERATION FOR SEISMIC HAZARDS,*
- *NBC 112 : TIMBER,*
- *NBC 201 : MANDATORY RULES OF THUMB REINFORCED CONCRETE BUILDINGS WITH MASONRY INFILL,*
- *NBC 202 : MANDATORY RULES OF THUMB LOAD BEARING MASONRY,*
- *NBC 203 : GUIDELINES FOR EARTHQUAKE RESISTANT BUILDING CONSTRUCTION: LOW STRENGTH MASONRY,*
- *NBC 207 : ELECTRICAL DESIGN REQUIREMENTS for (PUBLIC BUILDINGS),*
- *NBC 208 : SANITARY AND PLUMBING DESIGN REQUIREMENTS,*

NSET document references :

- *EARTHQUAKE RESISTANT : « a manual for the designers and builders »,*
- *EARTHQUAKE RESISTANT CONSTRUCTION OF BUILDINGS : « curriculum for mason training, guidelines for trainig instructors »,*

Site consideration :

- Quality of the soil : medium (Fine sand and silt dry lumps easily pulverized by the finger),
- Seismic zoning : Zone B,
- Categories of buildings for seismic strenthening purposes : I,

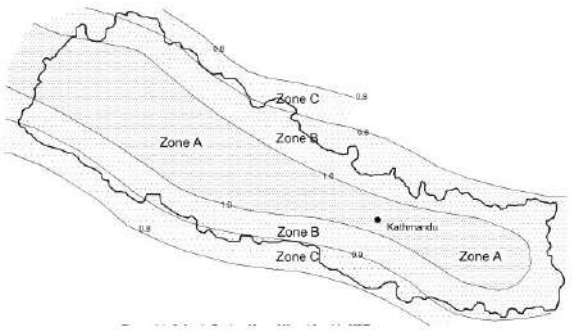


Figure 4.1 : Seismic Zoning Map of Nepal for this MRT

NBC 203

TABLE 6.1 : CATEGORIES OF BUILDINGS FOR SEISMIC STRENGTHENING PURPOSES

Category	Combination of Condition for the Category
I	Important Building on soft soil in Zone A*
II	Residential-cum-shop Building on Soft Soil in Zone*
III	Residential-cum-shop Building on Firm Soil in Zone A* Residential-cum-shop Building on Soft Soil in Zone B*
IV	Residential-cum-shop Building on Firm Soil in Zone B* Residential-cum-shop Building on Firm Soil in Zone C* Residential-cum-shop Building on Soft Soil in Zone C*

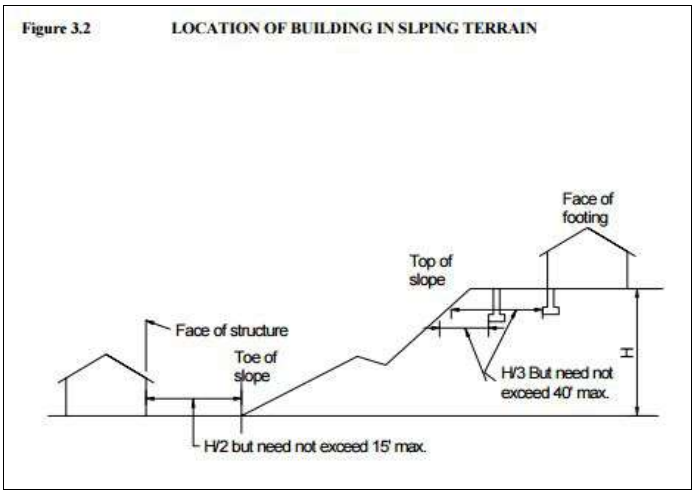
Important buildings in Category I (eg., Hospitals, Theatres, etc.) shall be designed by a competent professional designer.

* Zone : As per Seismic Zoning map of Nepal (**Figure 4.1**).

NBC 202

Location of building in sping terrain :

The implantation of the building respect the minimal distance betwwen the wall and toe of slope :
H/2 = 4,30m/2 = 2,15m → OK,

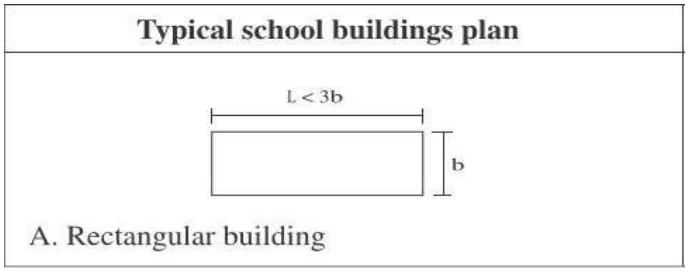


NBC 108

Geometrical configuration :

Lenght & width :

- Classrooms : L= 8,75m - b = 6,40,
  L<3x6,40 = 8,75 < 19,20 → OK,
- Store/bathroom : L= 12,90m - b = 6,40,
  L<3x6,40 = 12,90 < 19,20 → OK,



Height & wall thickness :

Classrooms & store/bathroom : H= 2,70m ,

=2,70m < 3,20m → OK,

Classrooms & store/bathroom : wall thickness

= 450 mm > 350 mm → OK,

TABLE 1.1 : BUILDING SIZE LIMITATIONS

	Floor	Min. Wall Thickness (mm)	Max. Height (m)	Max. Short Span of Floor (m)	Canti-lever (m)
Load-Bearing Brick Masonry in Cement Mortar	2nd	230	2.8	3.5	1.0
	1st	230	3.0	3.5	1.0
	Ground	350	3.2	3.5	No
Load-Bearing Stone Masonry in Cement Mortar, or	1st	350	3.0	3.2	No
Load-Bearing Brick Masonry in Mud Mortar	Ground	400	3.2	3.2	No
Load Bearing Brick Masonry in Mud Mortar	1st	350	3.0	3.2	No
	Ground	350	3.2	3.2	No

NBC 202

Openings:

Front view : b1 = 1,00m , L1 = 3,70m

= b1<0,3L1m = 1< 1,11 → OK,

b5 = 1,35m, h1 = 2,00m

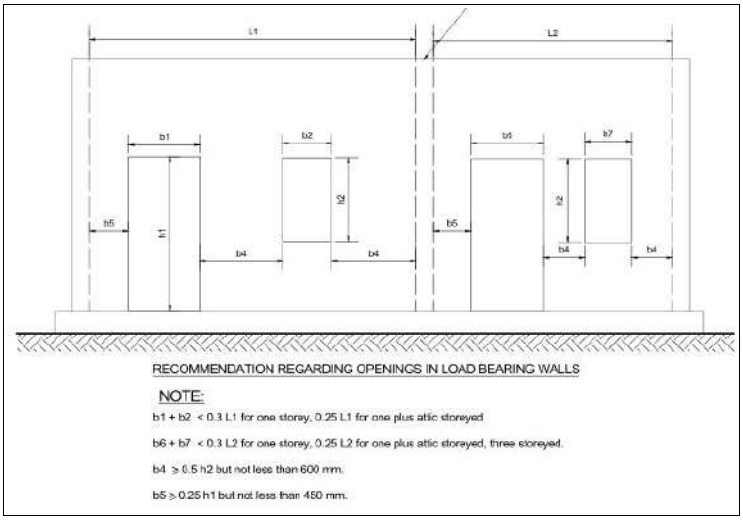
= b5>0,25h1 = 1,35m > 0,50m → OK,

Side view : b1-b2 = 0,90m , L1 = 5,50m

= b1+b2<0,3L1m = 1,8< 1,83 → OK,

b4 = 0,93m, h2 = 1,20m

= b4>0,5h2 = 0,93m > 0,60m → OK,



NBC 202

Fundation :

Width : 0,75m = 0,75m → OK,

Depth : 0,80m > 0,75m → OK,

SOIL TYPE	NO OF STOREY					
	One		Two		Two plus attic	
	Width	Depth	Width	Depth	Width	Depth
Hard	750	750	750	750	750	750
Medium	750	750	750	750	750	750
Soft	750	750	900	750	900	750

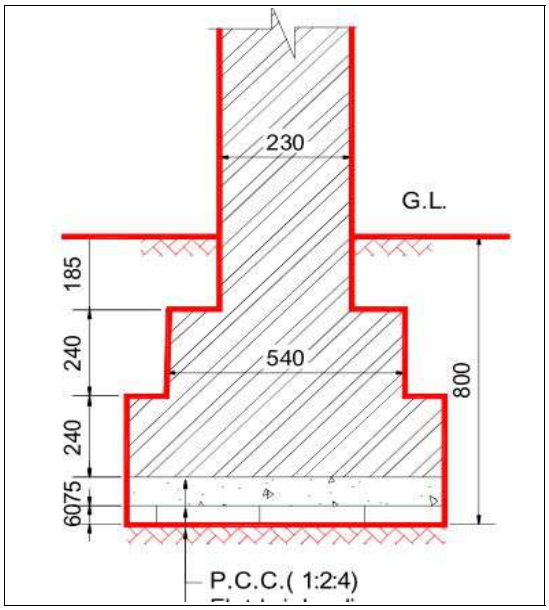
Table 6.1 : Size of Strip Footing for Different Soil Types

NBC 202

The fondation is composed of :

- Flat brick soling depth : 60 mm,
- RCC 1:2:4 depth : 75 mm,

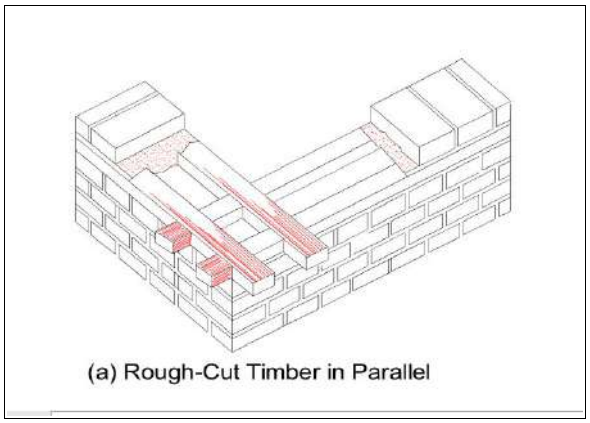
  Steel : 8 nos.12mm with 4,75mm diameter single legged strups at 150 mm spacing,
- Stone masonry cement 1:6 depth : 66,5 mm,



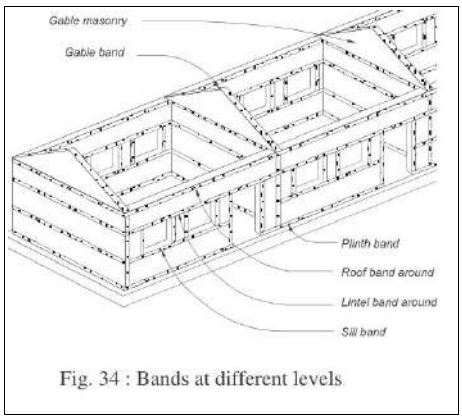
NBC 203

Wall :

The wall is Reinforced by horizontale timber bands at different level in the wall (plinth, sill, stitch, linter, roof ang gabbler band = 6 horinzontale bands). The timber section is detailed on the plan in attachment. The flat stone is located between the timber at the center.

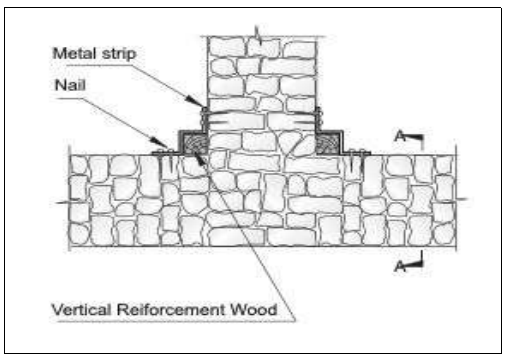


Corner detail

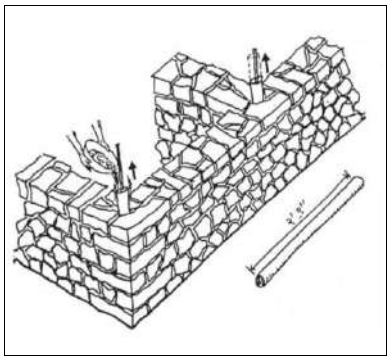


Band localisation

Each corner/jonction in the wall is reinforced by vertical timber post (plinthe band → roof band) and vertical iron bar (fundation → roof band) ,



Vertical timber post (140x140mm)



Vertical iron bar *(16 mm x1)*

Roof :

The structure is composed of :

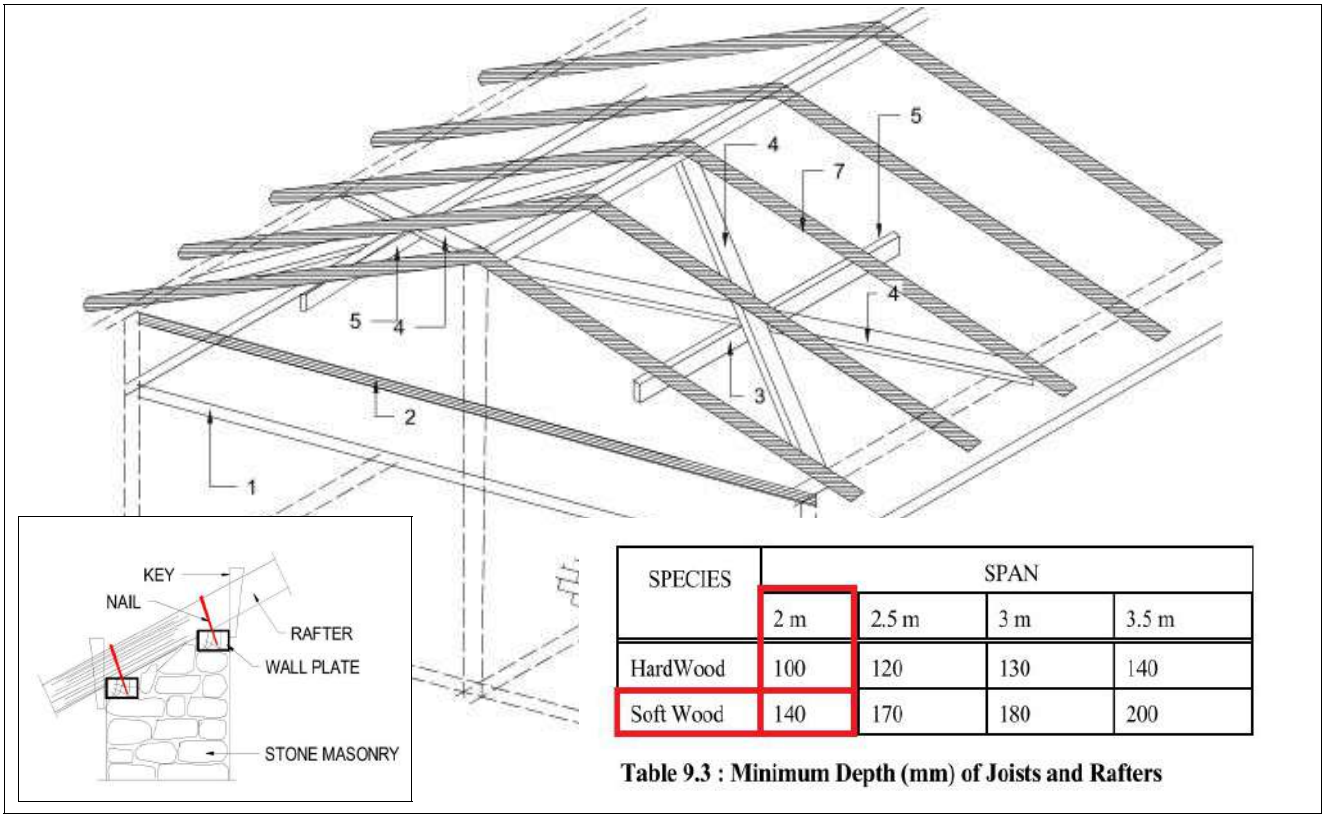
2 : Timber roof band,

3 : Timber Joist (140 x75 mm),

4 : Timber diagonal bracing (100 x 75 mm),

7 : Timber rafter (140 x 75 mm),

The detail show the assembly between the rafter and the timber roof band by key.



SPECIES	SPAN			
	2 m	2.5 m	3 m	3.5 m
HardWood	100	120	130	140
Soft Wood	140	170	180	200

Table 9.3 : Minimum Depth (mm) of Joists and Rafters

NBC 202-203

The roof slope is 2/1 – 27° in respect of the sates of arts (NBC 106 : snow load).

NEPAL – RASUWA – SCHOOL THUMAN – REBUILDING PROJECT								
ESTIMATE CONSTRUCTION COST : material unit price of march 2016 (source : Saraswati),								
MATERIELS + TRANSPORATION (KTM- Syaphru)					***TRANSPORTATION CARRIER (Syaphru – Thuman)***			TOT Cost (Rs)
Designation	Volume	Unit	Unit price (Rs)	Cost (Rs)	Weight (kg)	No,Tr/ 50 kg	Cost (Rs) 1200	
Cement	11 880	kg	35	415 800	11 880	238	285 120	*700 920*
Sand	55 252	kg	14	773 528	55 252	1 105	1 326 048	*2 099 576*
Iron bar	2 840	kg	4	11 360	2 840	57	68 160	*79 520*
Plywood	576	sq ft	66	38 016	180	4	4 320	*42 336*
Door size : 7' x 3'	13	U	5 000	65 000	650	13	15 600	*80 600*
Window size : 4,6' x 6'	24	U	3 000	72 000	720	14	17 280	*89 280*
CGI sheet 1,5 kg/sq ft	6 300	sq ft	120	756 000	2 898	58	69 552	*825 552*
Electric instalation	13	U	10 000	130 000	260	5	6 240	*136 240*
Sanitery instalation	2	U	25 000	50 000	500	10	12 000	*62 000*
TOT				2 311 704	74 420	1 488	1 786 080	*4 116 024*
							TOT/house RS	*633 234*
							TOT/house €	*5 277*
LABOR								
Designation	No. worker	Time/ house	Unit	Tot time x 6,5	Unit	Daily price	Unit	Tot cost
LOCAL LABOR (production and transportation of local materials)								
Stone 40 m3 : 100kg/daily/people	10	10,0		65,0		12 000		*780 000*
Gravel 14 500 kg : 150kg/daily/people	10	10,0		65,0		12 000		*780 000*
Timber 16 m3 : 0,1 m3/daily/people	10	15,0		97,5		12 000		*1 170 000*
SKILL LABOR (construction)								
Excavation	5	10,0		65,0		6 000		*390 000*
Fundation	5	5,0		32,5	j	6 000		*195 000*
Wall	5	20,0		130,0	j	6 000		*780 000*
roof : framing	5	10,0		65,0	j	6 000		*390 000*
Roof : CGI-sheet :	5	1,0		6,5	j	6 000		*39 000*
Topping concrete	5	1,0		6,5	j	6 000		*39 000*
Plywood ceiling	5	0,5		3,3	j	6 000		*19 500*
Door and windows	5	2,0		13,0	j	6 000		*78 000*
Electric instalation	1	2,0		13,0	j	1 200		*15 600*
Sanitery instalation	2	4,0		26,0	j	2 400		*62 400*
TOT		84,5		549,25				*4 738 500*
							TOT/house RS	*729 000*
							TOT/house €	*6 075*
SUMMARY								
DECOMPOSITION		TOT/house		%		TOT/houses	Rs	*1 362 234*
MATERIAL + TRANSP (KTM-SYAPHRU)		2 964 €		26%		TOT	Rs	*8 854 524*
TRANSPORTATION (SYAPHRU - THUMAN)		2 290 €		20%				
LABOR		6 075 €		54%		TOT/houses	€	*11 352*
		7 975 €				TOT	€	***73 788***

Important notes :

- *Material unit price of march 2016 (source saraswati : factory to Trisuli),*
- *Exchange rate : 120 Rs = 1€,*
- *Profit of constructor no included,*
- *Study and administrative costs no included,*
- *Labor : accomodation and food non included,*
- *Daily cost labor : 1 200 Rs,*
- *Weight per transportation from syaphru to Thuman : 50 kg per donkey,*
- *Daily cost per transportation per donkey from syaphru to Thuman : 1 200 Rs (guide included),*
- *The stone, gravel and timber are free and open access,*

Schedule

Construction advancements ***are limited by the transportation of materials.***

Transportation :

No. transportation per donkey : 1 450,
No. donkey avalaible per day : 10,

No. day : 145 = 5 month,

Construction (labor adapted to transportation)

No.worker per house : 15,
No.days per 1 houses : 16,

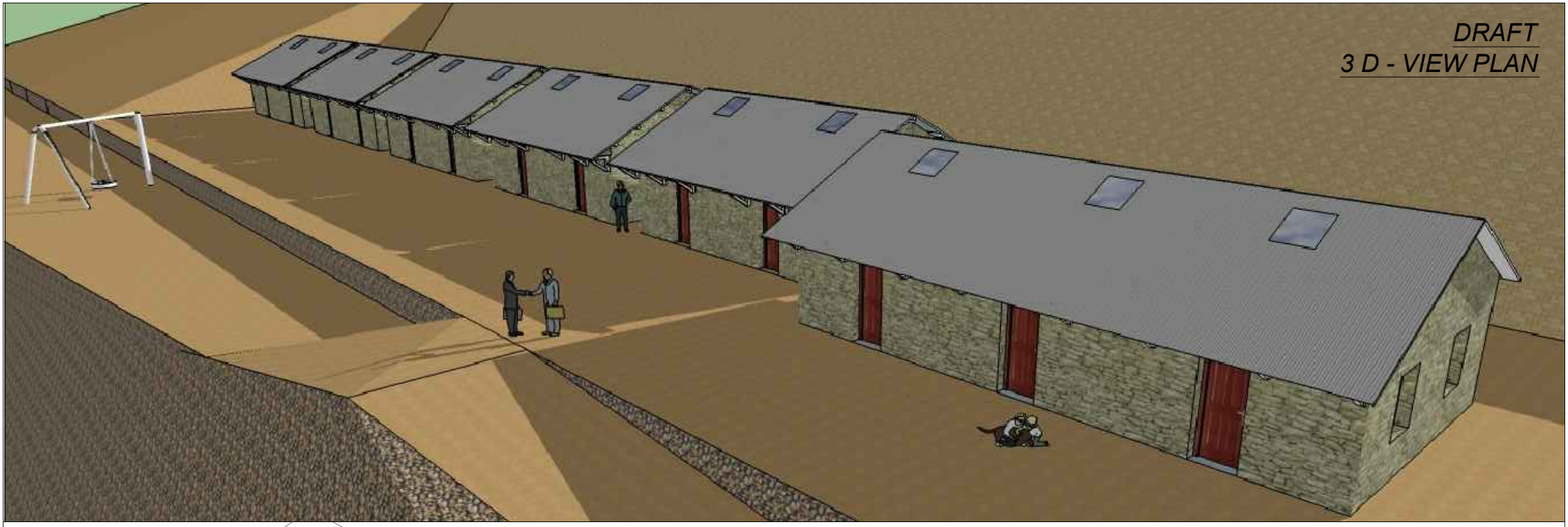
No. days per 6 houses : =110 days = 4,5 month,

THUMAN SCHOOL PROJECT

TECHNICAL DRAWING

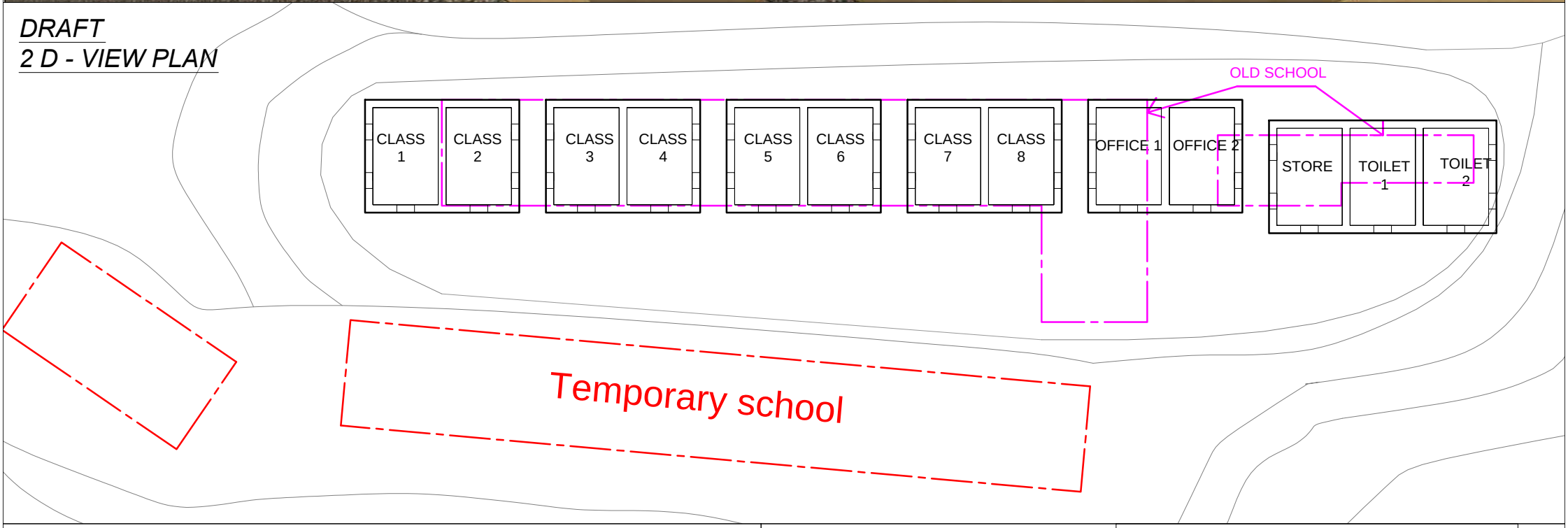
THIS DOCUMENT INCLUDED : 14 PLANS

SARASWATI - SOLHIMAL : 21-03-2016



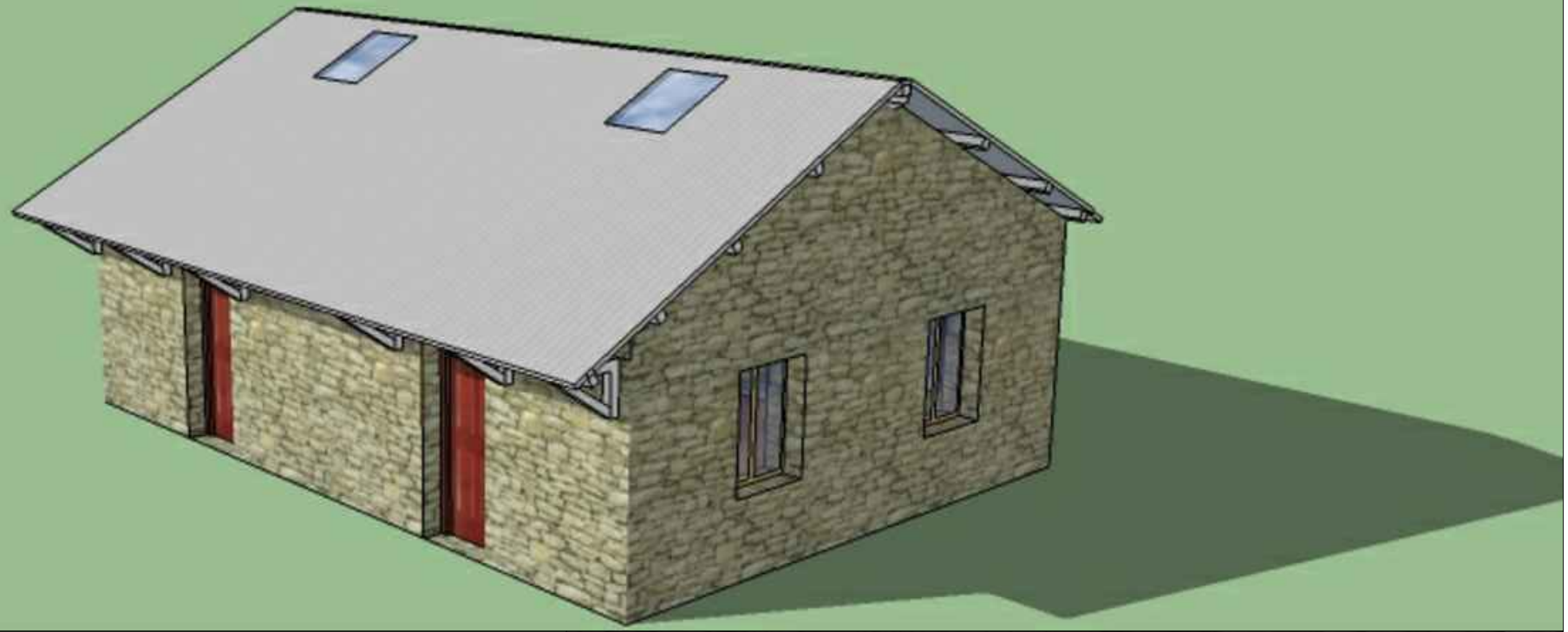
DRAFT
3 D - VIEW PLAN

DRAFT
2 D - VIEW PLAN

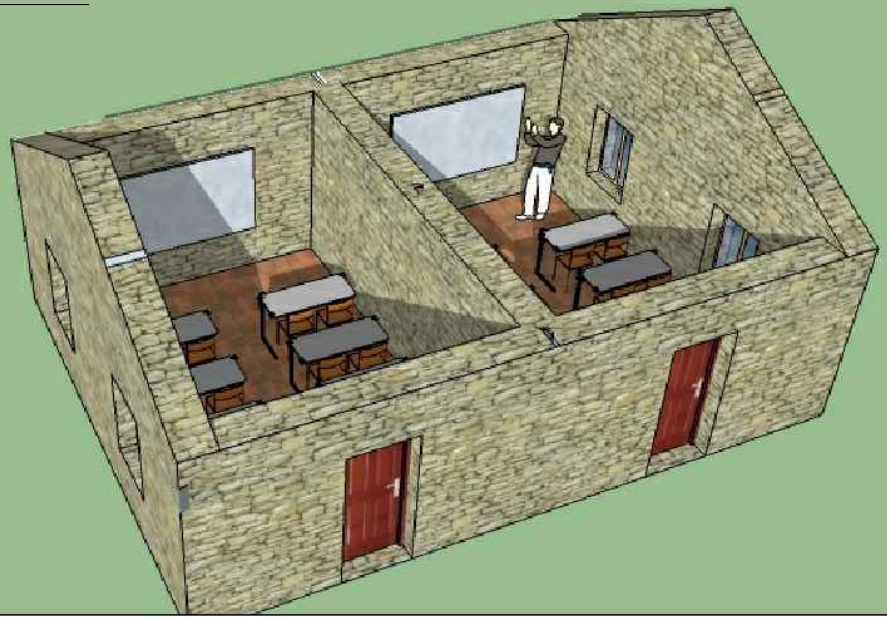


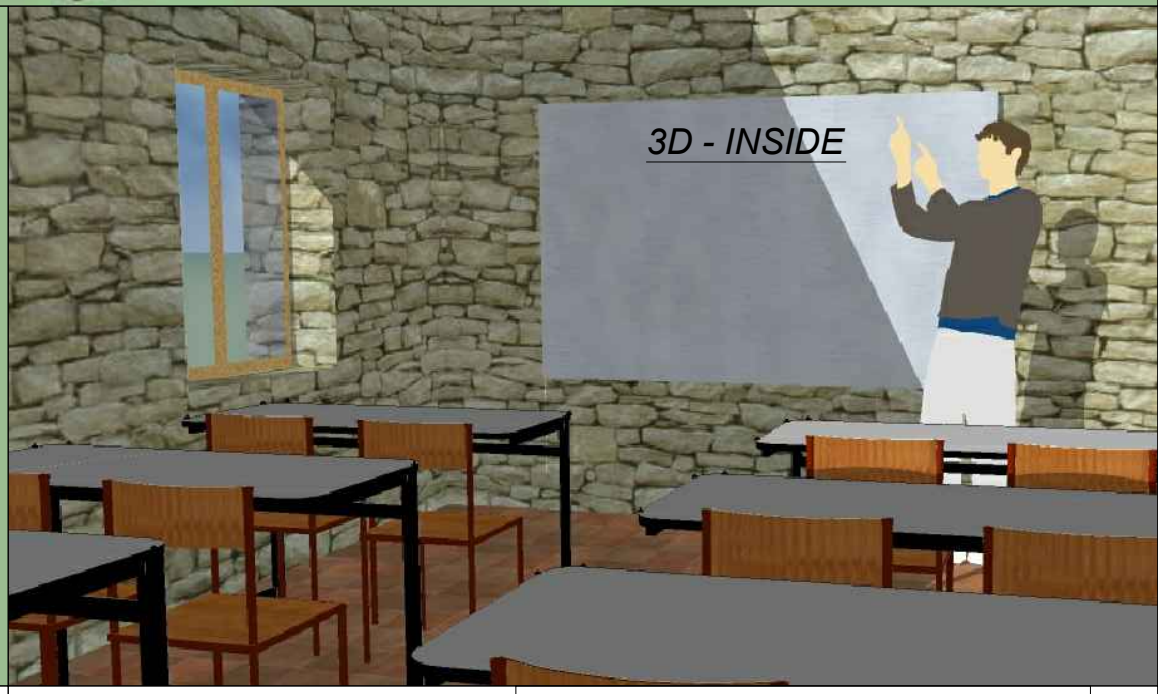
THUMAN SCHOOL EARTHQUAKE RESISTANCE	ALL DIMENTION ARE IN METERS	SARASWATI - SOLHIMAL : 21-03-2016	1-14

CLASSROOM
DRAFT
3D - OUTSIDE



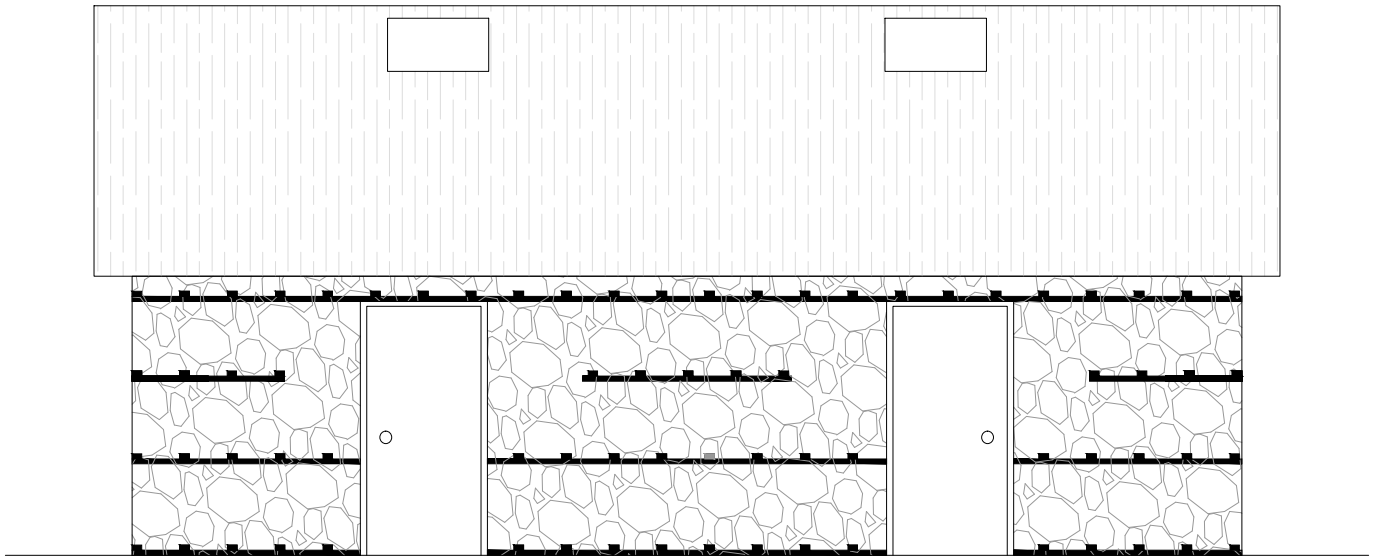
3D - INSIDE



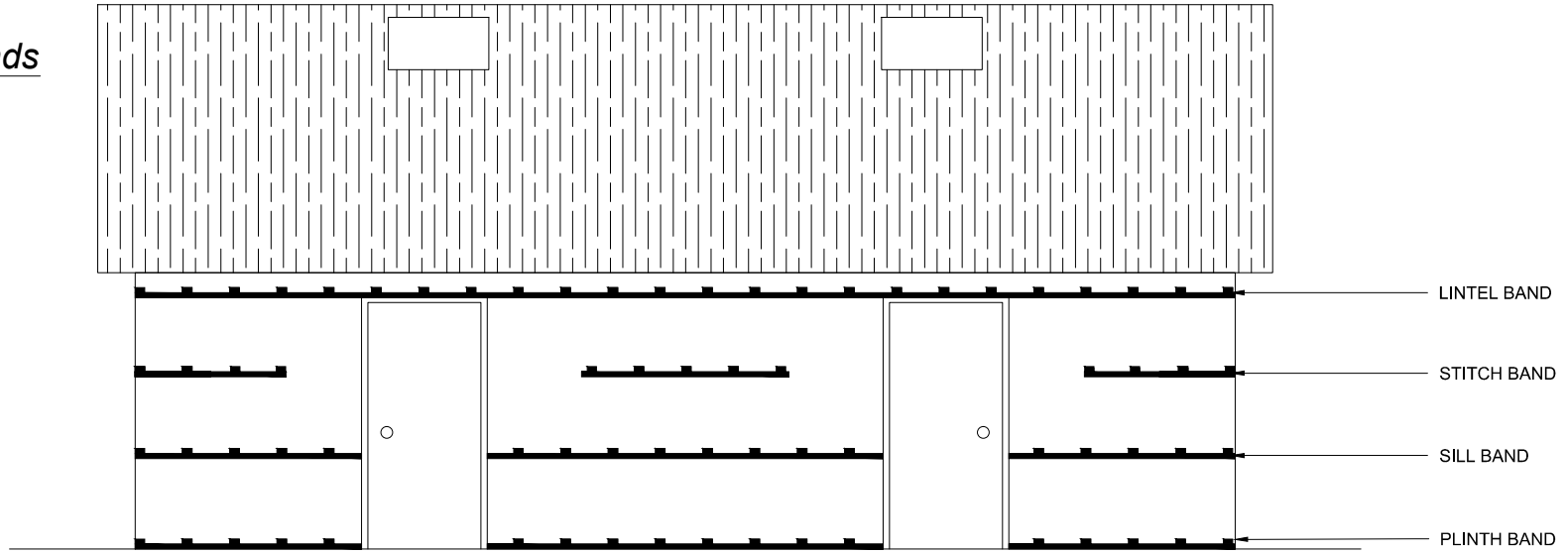


THUMAN SCHOOL EARTHQUAKE RESISTANCE | ALL DIMENTION ARE IN METERS | SARASWATI - SOLHIMAL : 21-03-2016 | 2-14

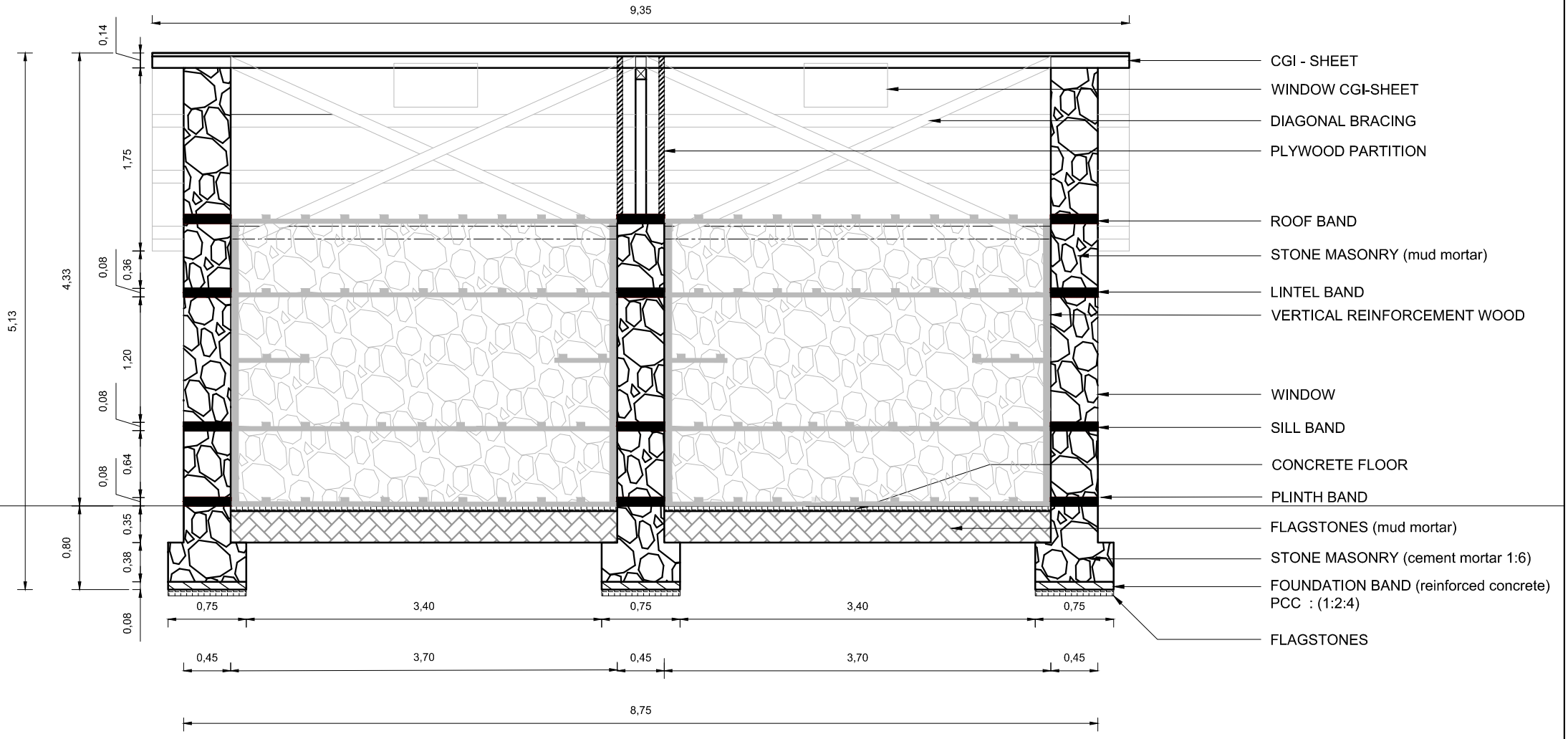
CLASSROOM
FRONT - VIEW



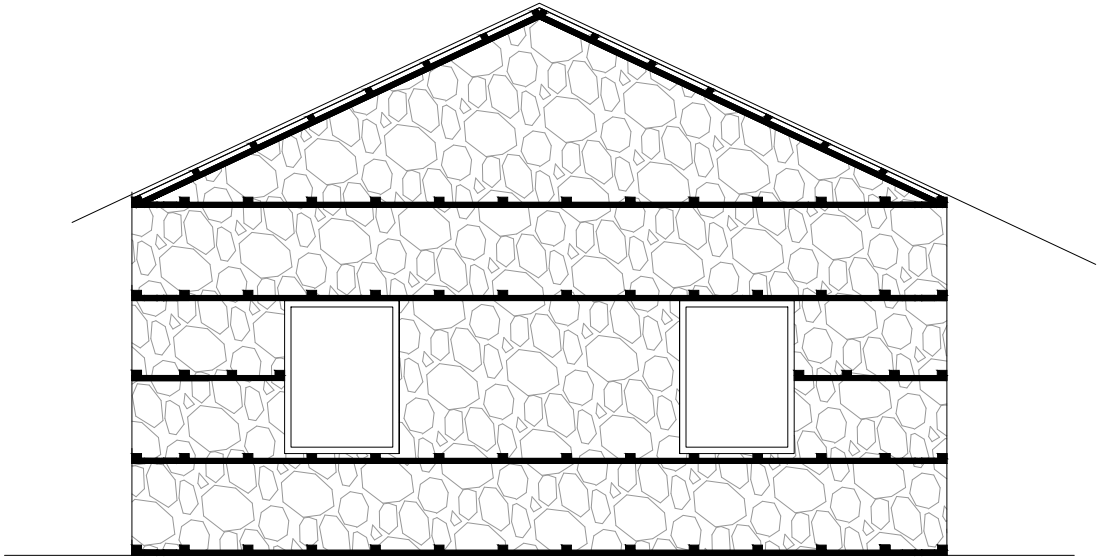
CLASSROOM
FRONT - VIEW
Horizontal timber bands



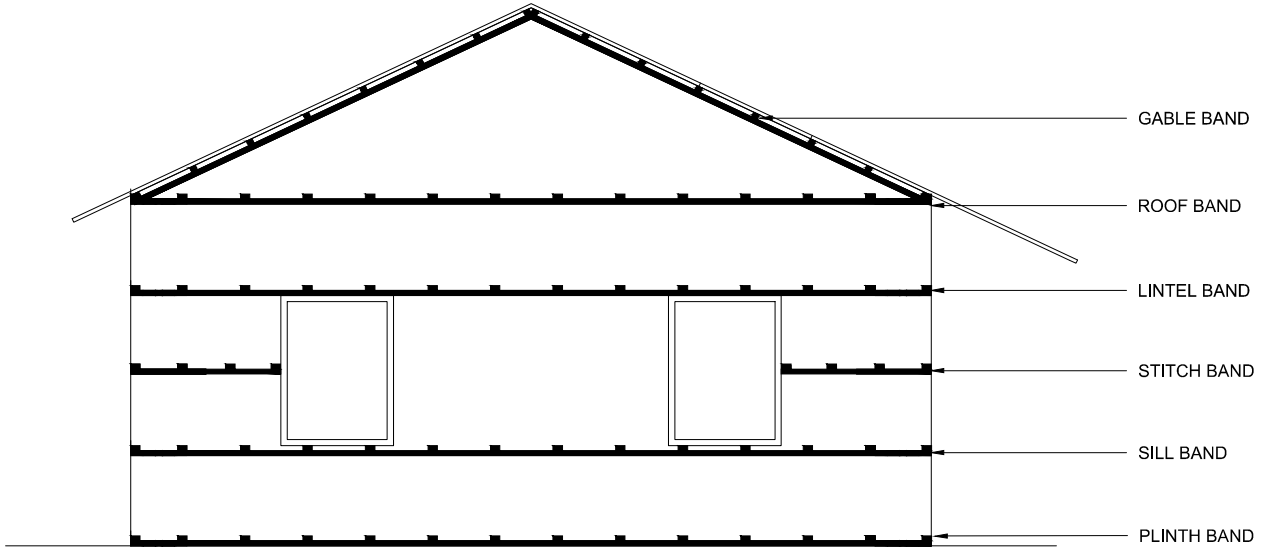
CLASSROOM
FRONT - VIEW
CROSS SECTION



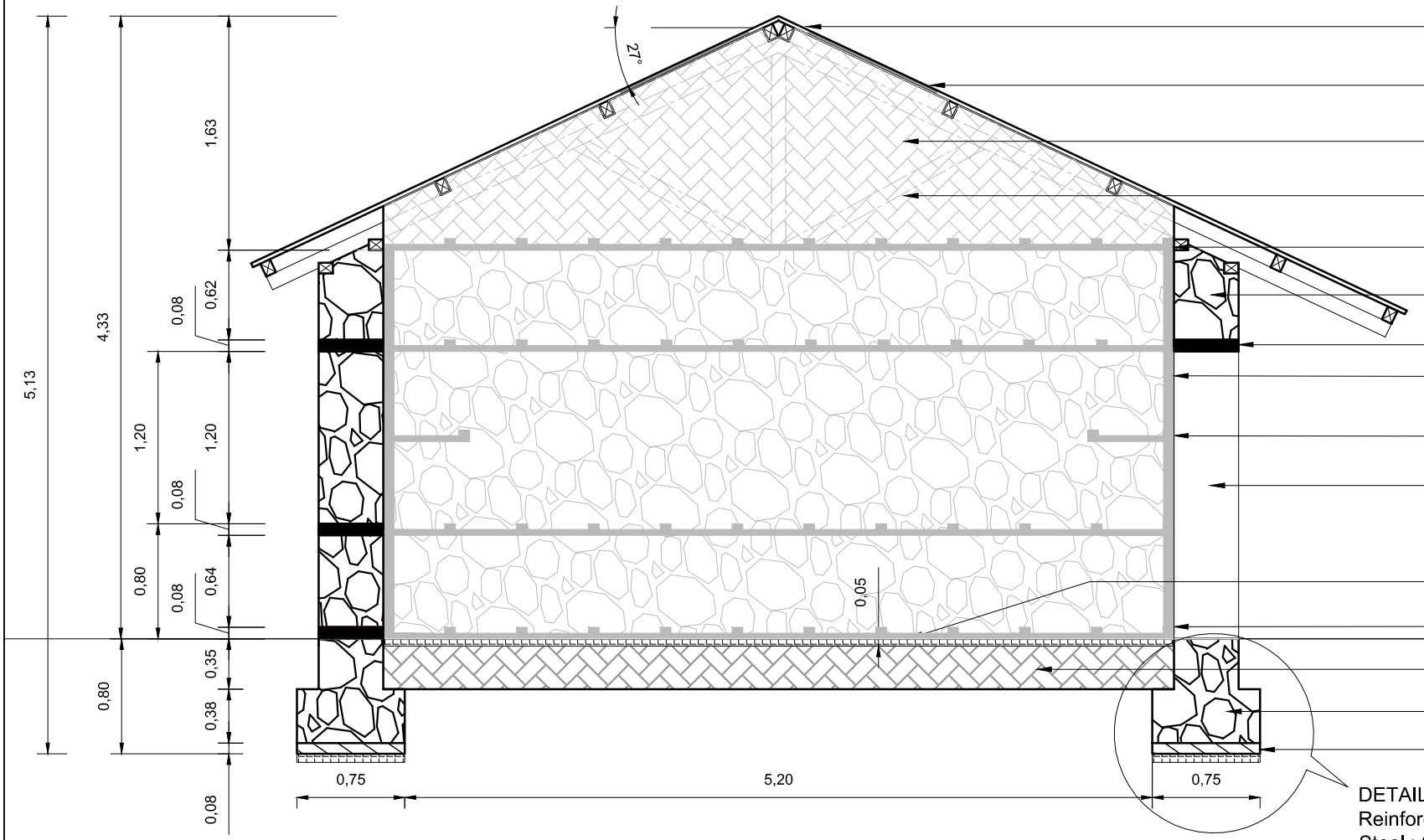
CLASSROOM
SIDE - VIEW



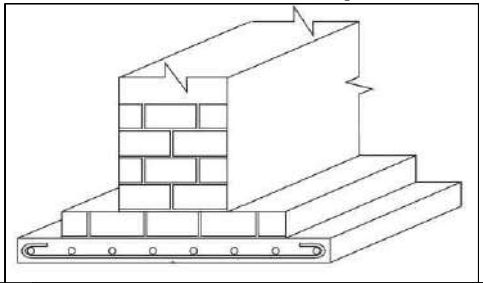
CLASSROOM
SIDE - VIEW
Horizontal timber bands



CLASSROOM
SIDE - VIEW
CROSS SECTION

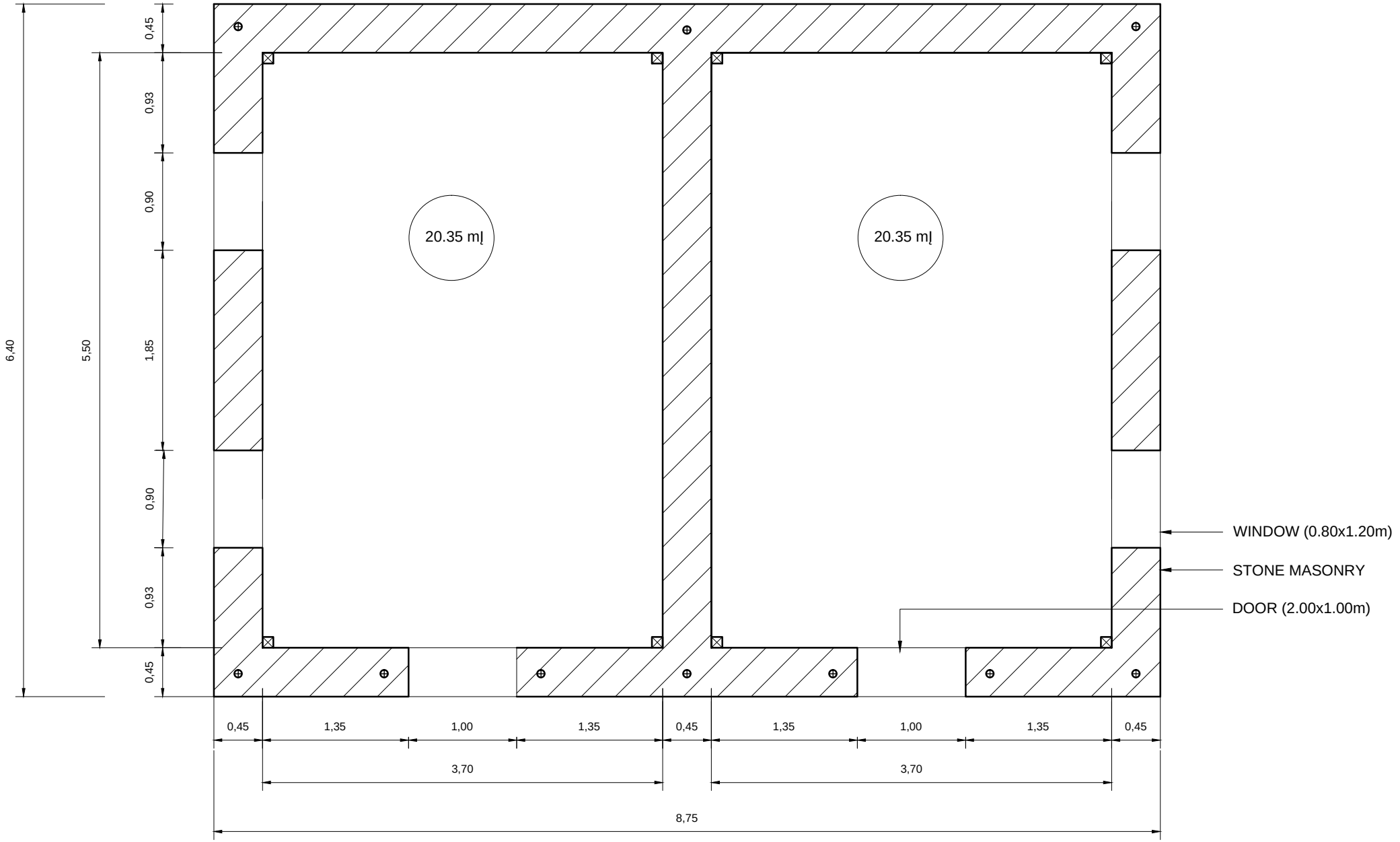


DETAIL :
Reinforced concrete
Steel : 6 nos. 12 mm diameter bars
with 4.75 mm diameter single at 150mm spacing

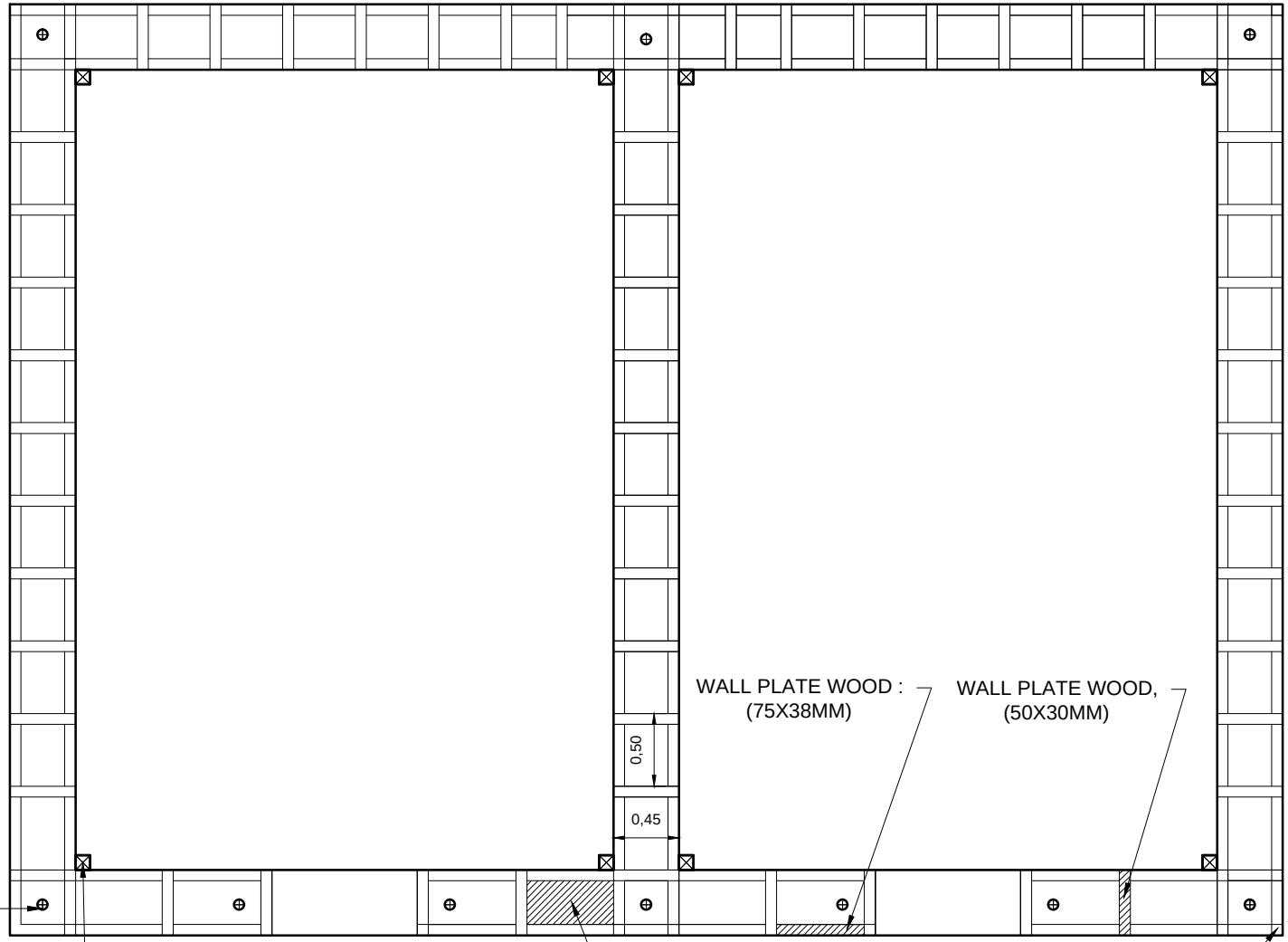


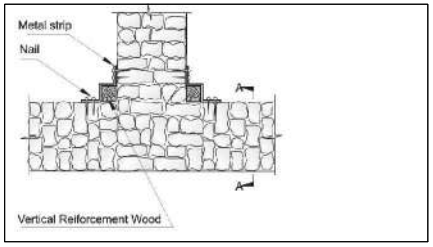
THUMAN SCHOOL EARTHQUAKE RESISTANCE	ALL DIMENTION ARE IN METERS	SARASWATI - SOLHIMAL : 21-03-16	6-14

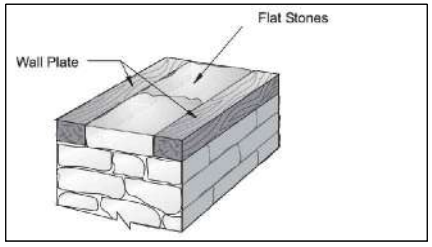
CLASSROOM
PLAN VIEW :
WALL : STONE MASONRY

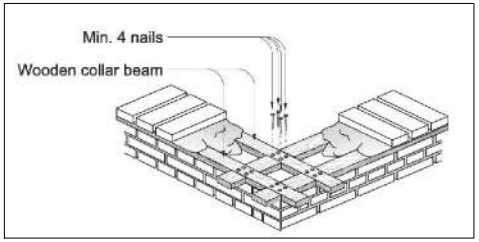


CLASSROOM
PLAN VIEW :
PLINTH & SILL BANDS

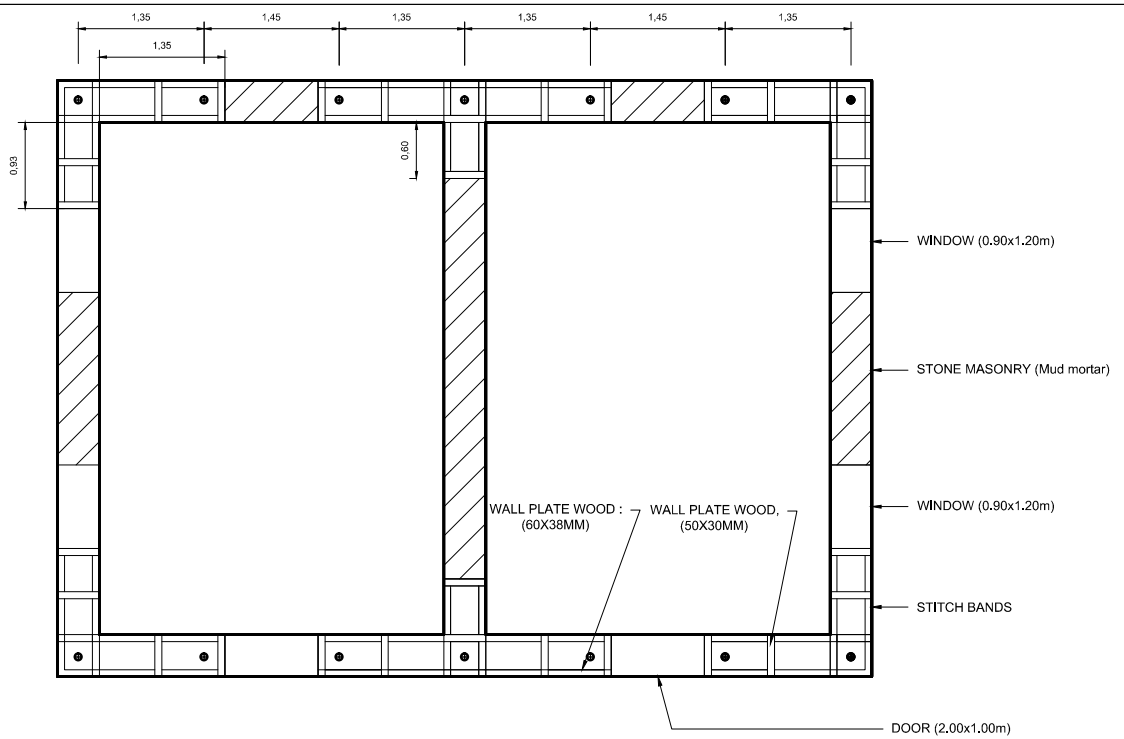




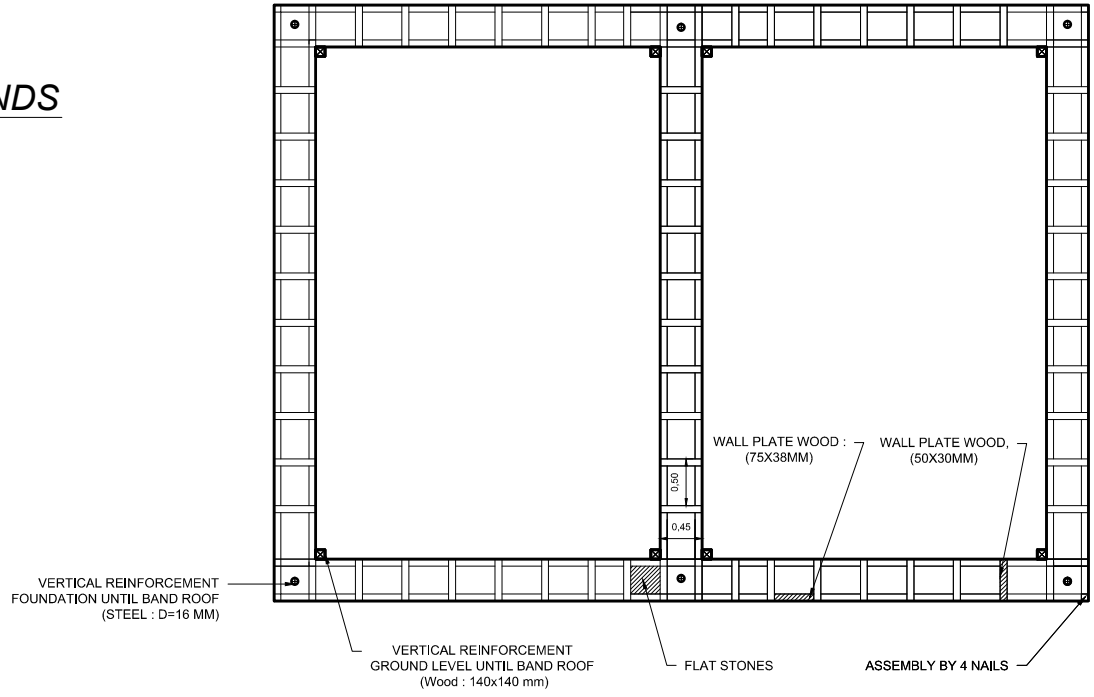




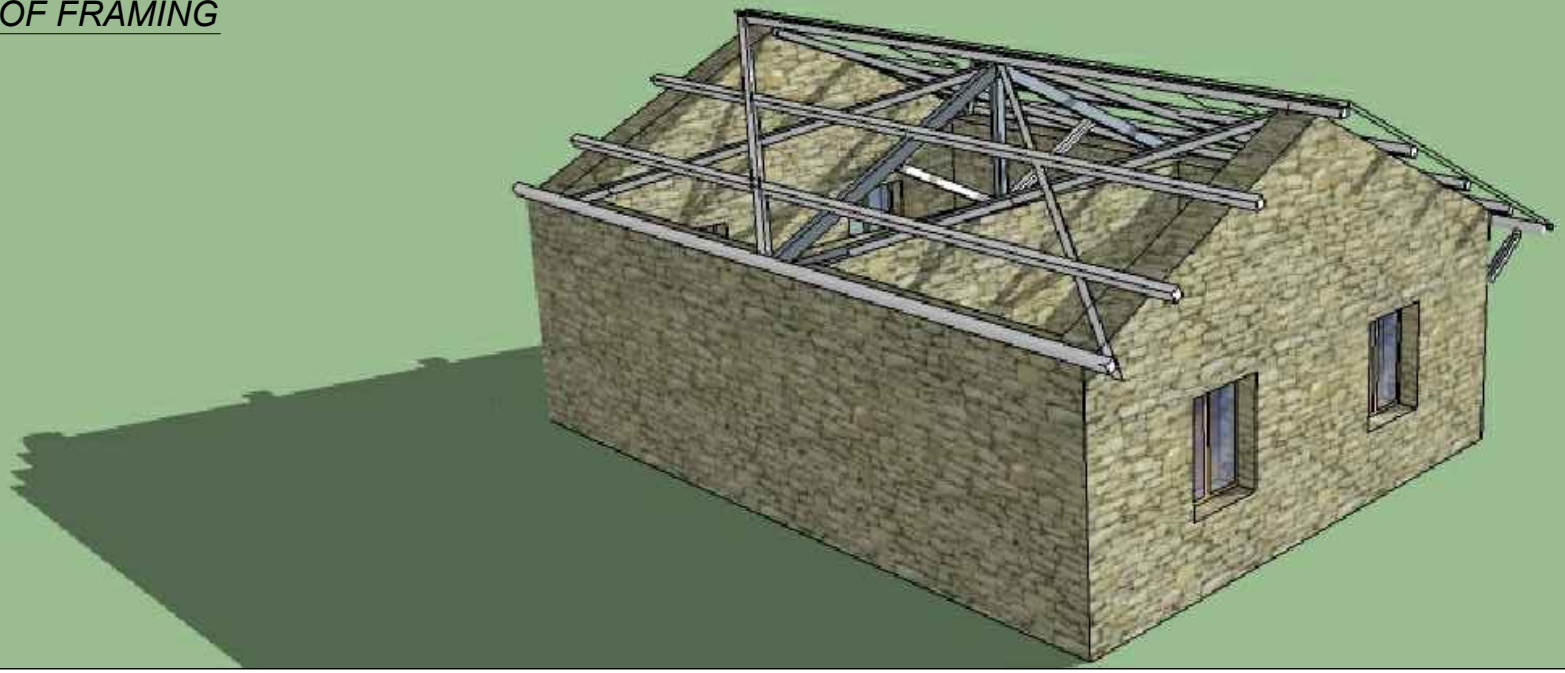
CLASSROOM PLAN VIEW : STITCH BANDS

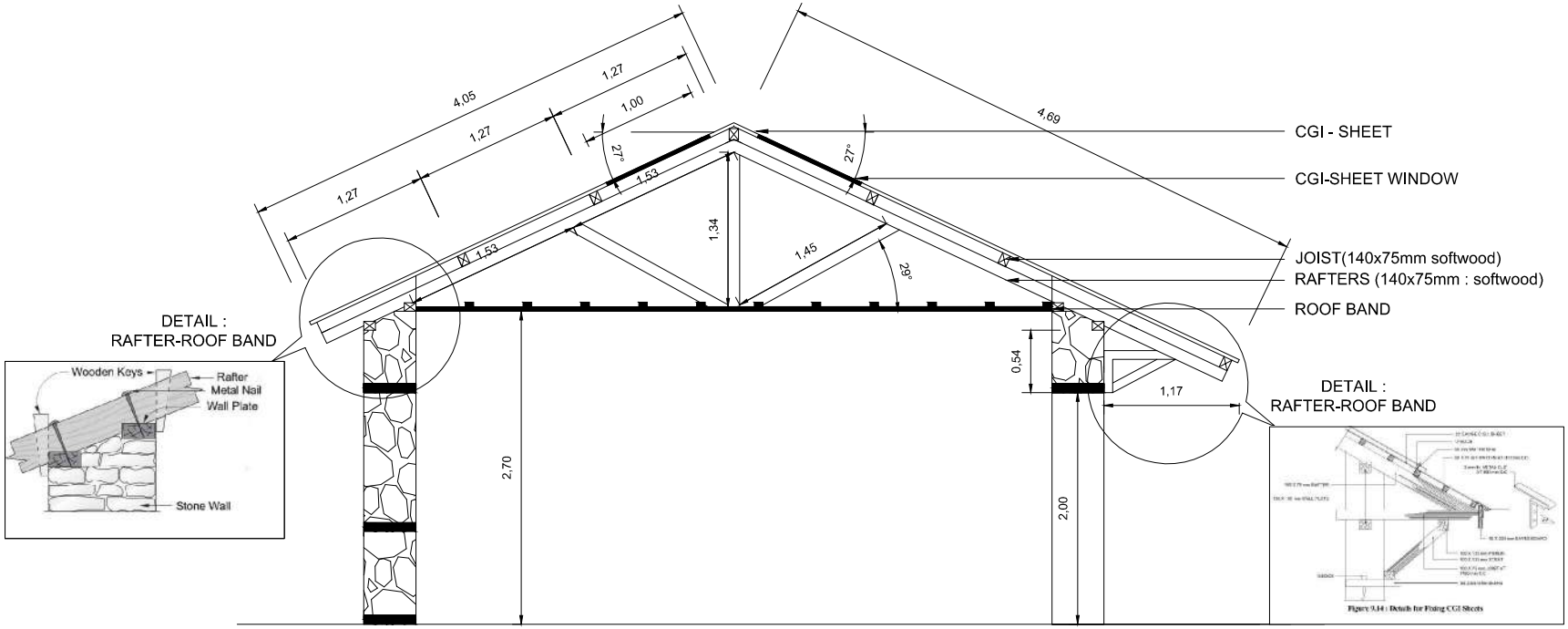


CLASSROOM PLAN VIEW : LINTEL & ROOF BANDS



CLASSROOM
ROOF FRAMING





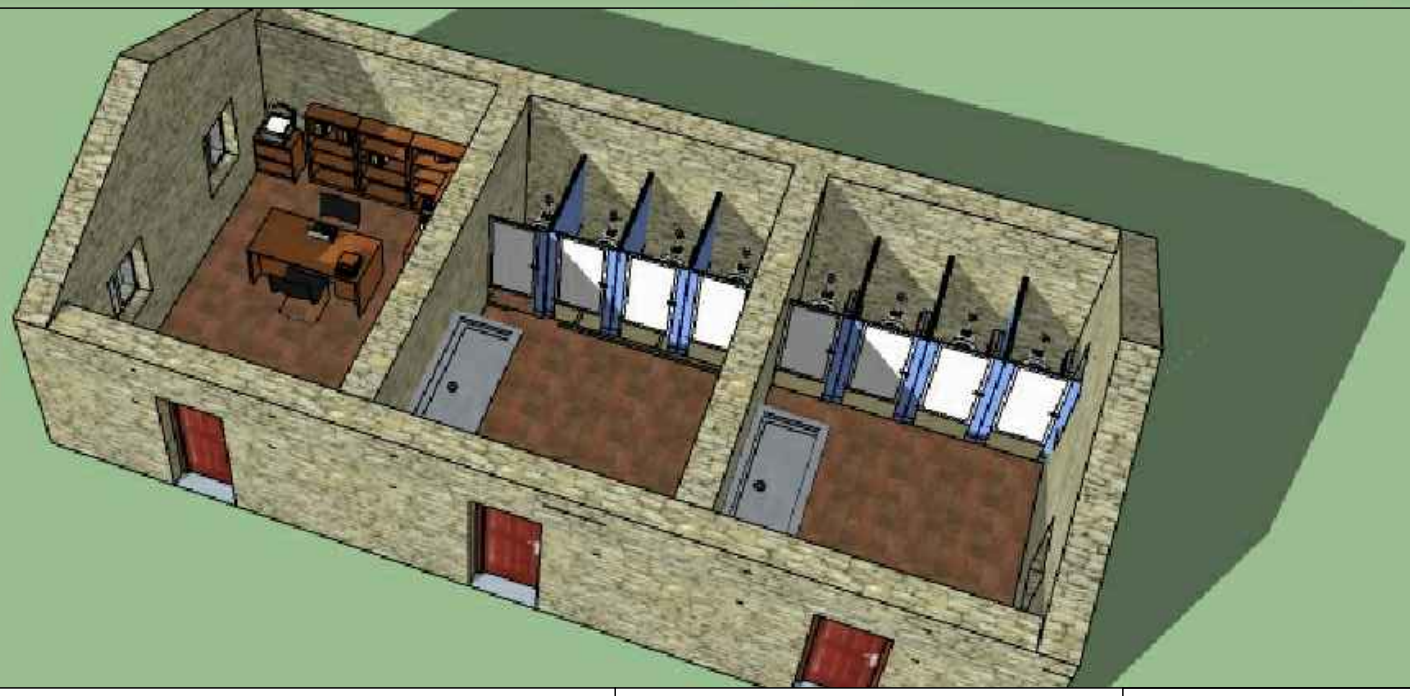
THUMAN SCHOOL EARTHQUAKE RESISTANCE	ALL DIMENTION ARE IN METERS	SARASWATI - SOLHIMAL : 21-03-2016	10-14

STORE & BATHROOM

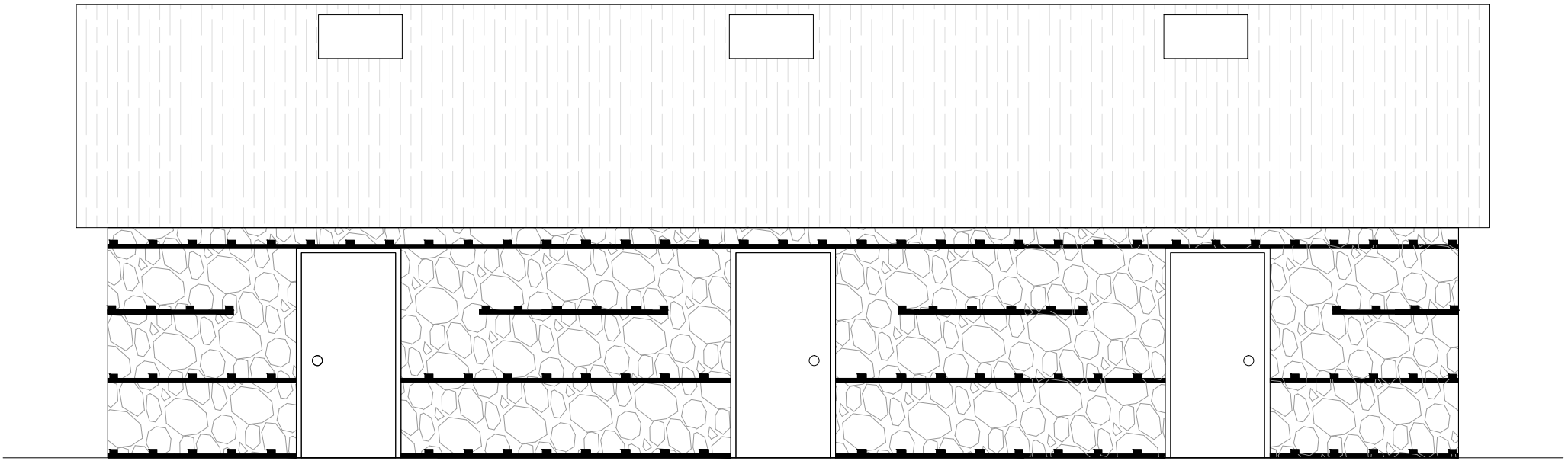
3D - OUTSIDE

DRAFT

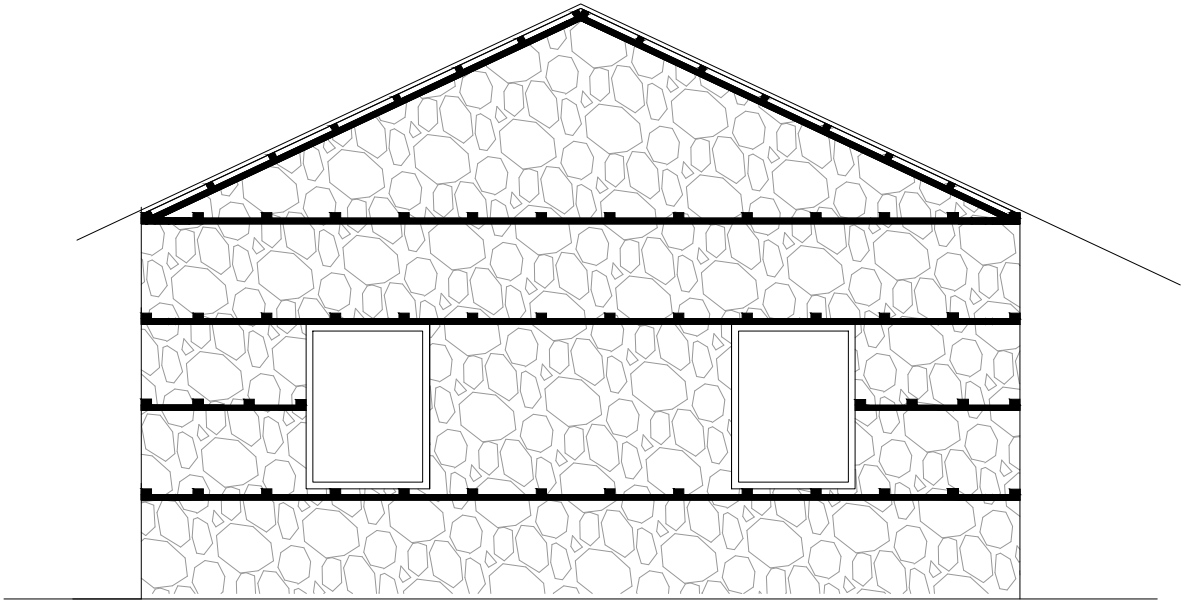
3D - CROSS INSIDE



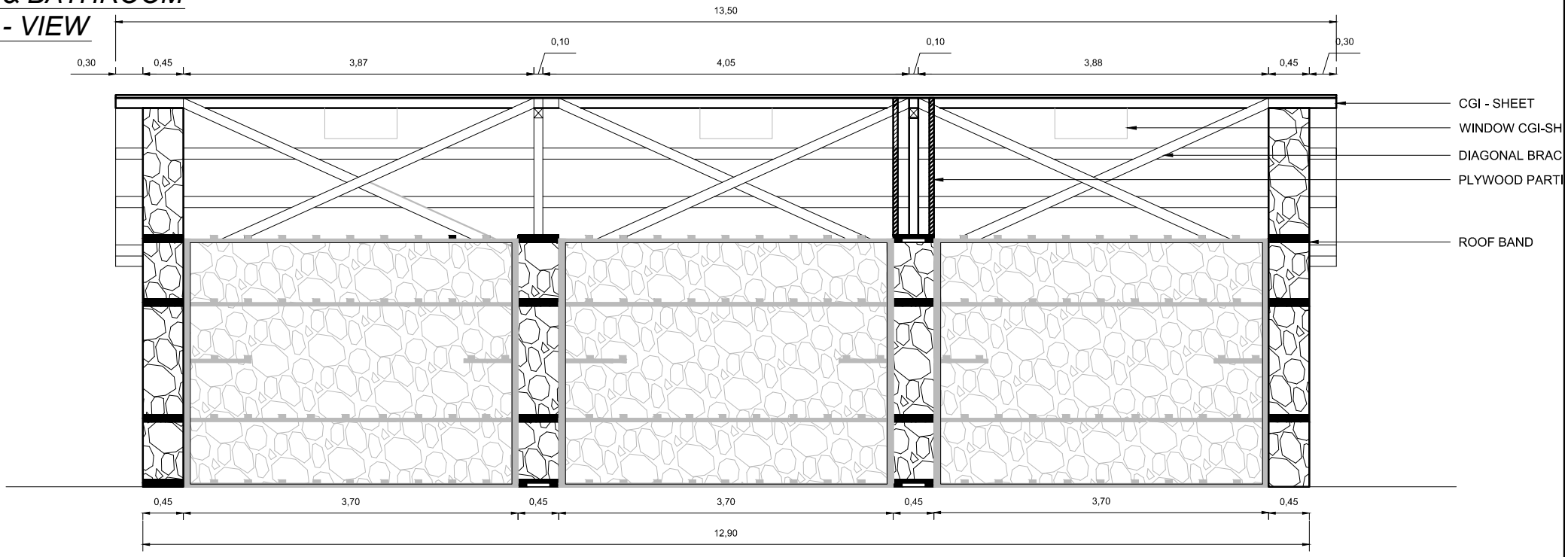
STORE & BATHROOM
FRONT - VIEW



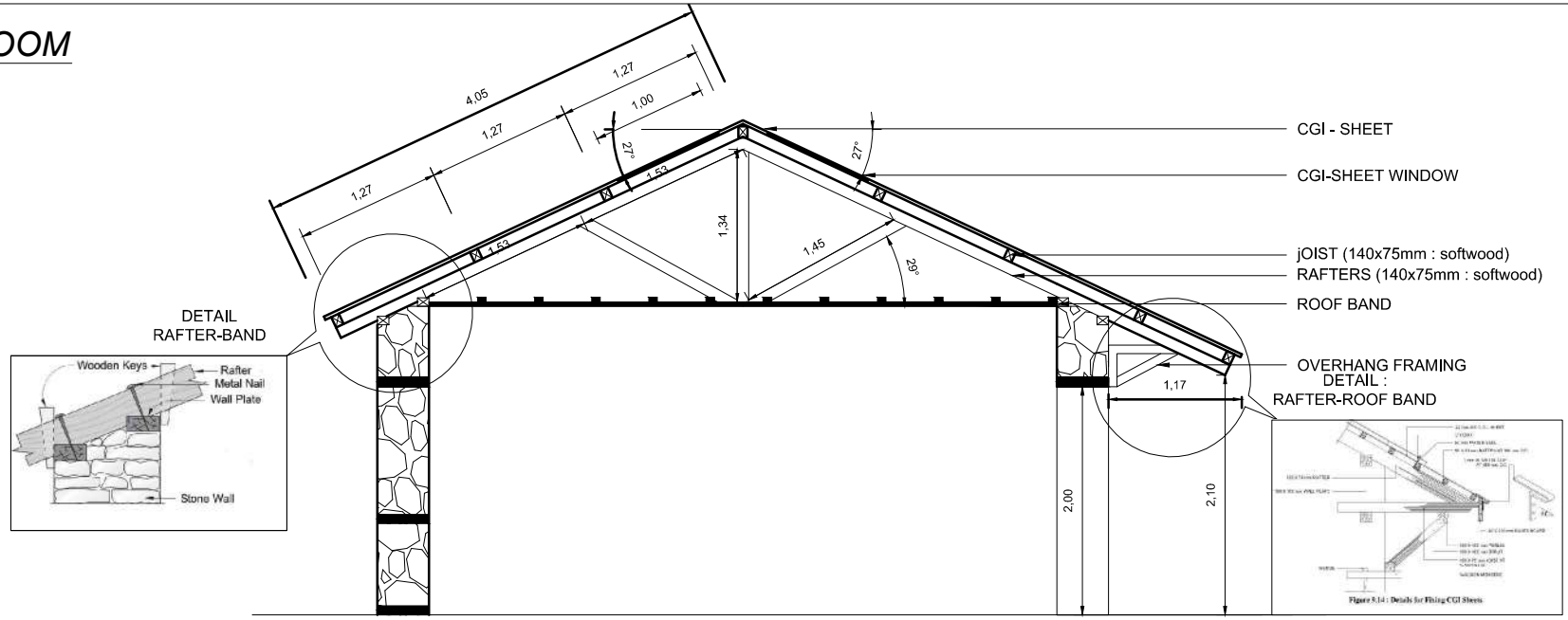
STORE & BATHROOM
SIDE - VIEW



STORE & BATHROOM
FRONT - VIEW

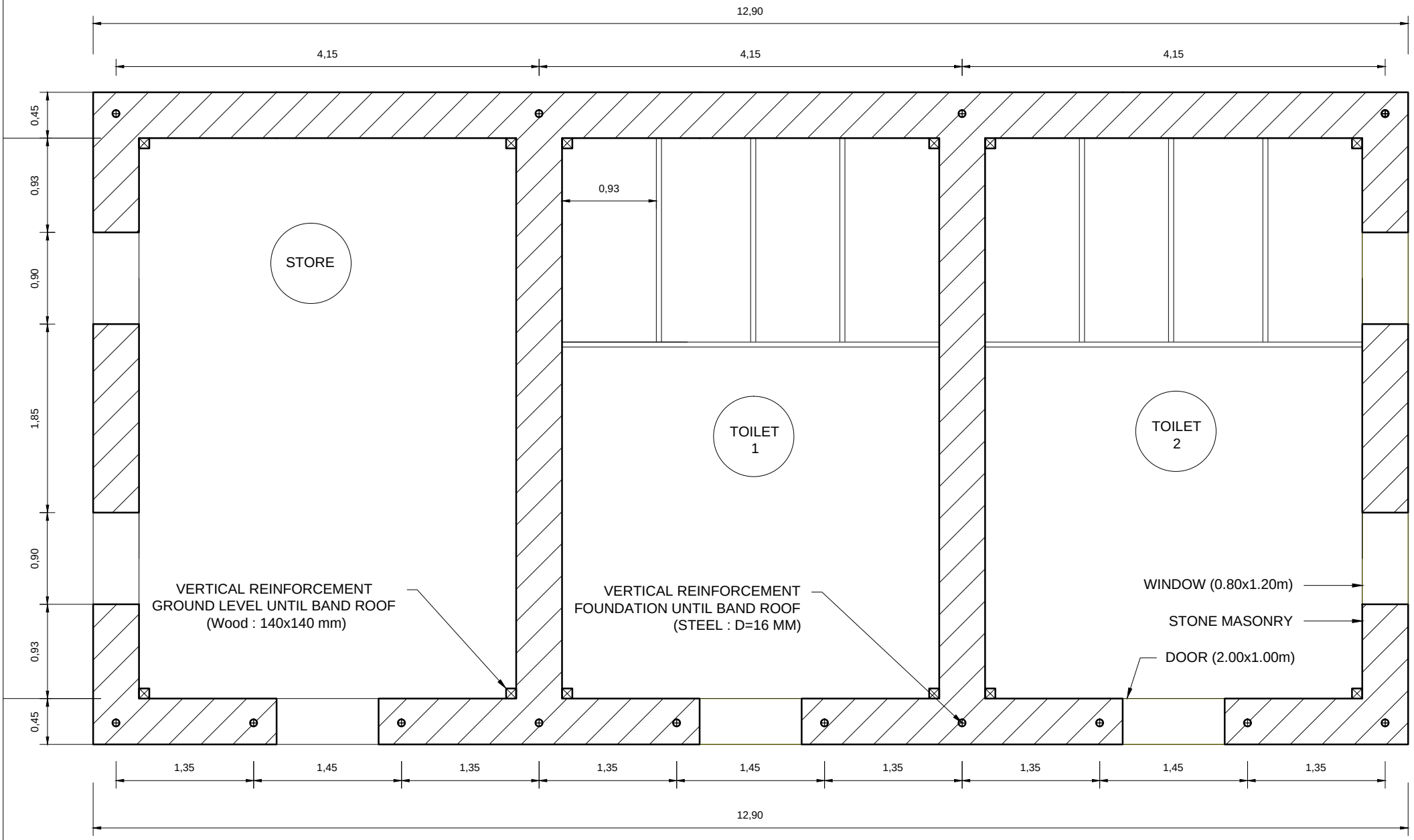


STORE & BATHROOM
SIDE - VIEW



THUMAN SCHOOL EARTHQUAKE RESISTANCE	ALL DIMENTION ARE IN METERS	SARASWATI - SOLHIMAL : 21-03-16	13-14

CLASSROOM
PLAN VIEW :
WALL : STONE MASONRY



THUMAN SCHOOL EARTHQUAKE RESISTANCE	ALL DIMENTION ARE IN METERS	SARASWATI - SOLHIMAL : 21-03-2016	14-14