(5)

DEMONSTRATION BUILDING

PRIMARY SCHOOL

LOC DIEN / PHU LOC DISTRICT

April 1989

VIET/85/019

Disaster preparedness and rehabilitation in Binh Tri Thien Province , Vietnam
Sử bảo vệ chống thăm-hoa thiên-nhiên ở tỉnh Bình Trị Thiên , Việt Nam

VIET/85/019

CHUYỂN GIAO KỸ THUẬT XÂY DỰNG NHÀ CHỐNG GIÓ BÃO
DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES

DEMONSTRATION BUILDING

PRIMARY SCHOOL

LOC DIEN VILLAGE / PHU LOC DISTRICT

April 1989

Development Workshop

Viện Thiết Kế Nhà Ở - Công Trình Công Cộng, Hànội
Institute For Housing and Public Building Design

Xí Nghiệp Thiết Kế Khảo Sát Xây Dựng, Huế
Institute For Building Investigation and Design

GRET

Project VIET/85/019 Disaster preparedness and rehabilitation in Binh Tri Thien Province

Financing : PNUD
Executing agency : UNCHS - Habitat, Nairobi KENYA

Sub-Project N°3 Demonstration of storm resistant building techniques

Vietnamese counterpart : Institute for Housing and Public Building Design, Hanoi VIETNAM
Institute for Building Investigation and Design, Hué VIETNAM

Sub-contractor : GRET (Groupe de Recherche et d'Echanges Technologiques)
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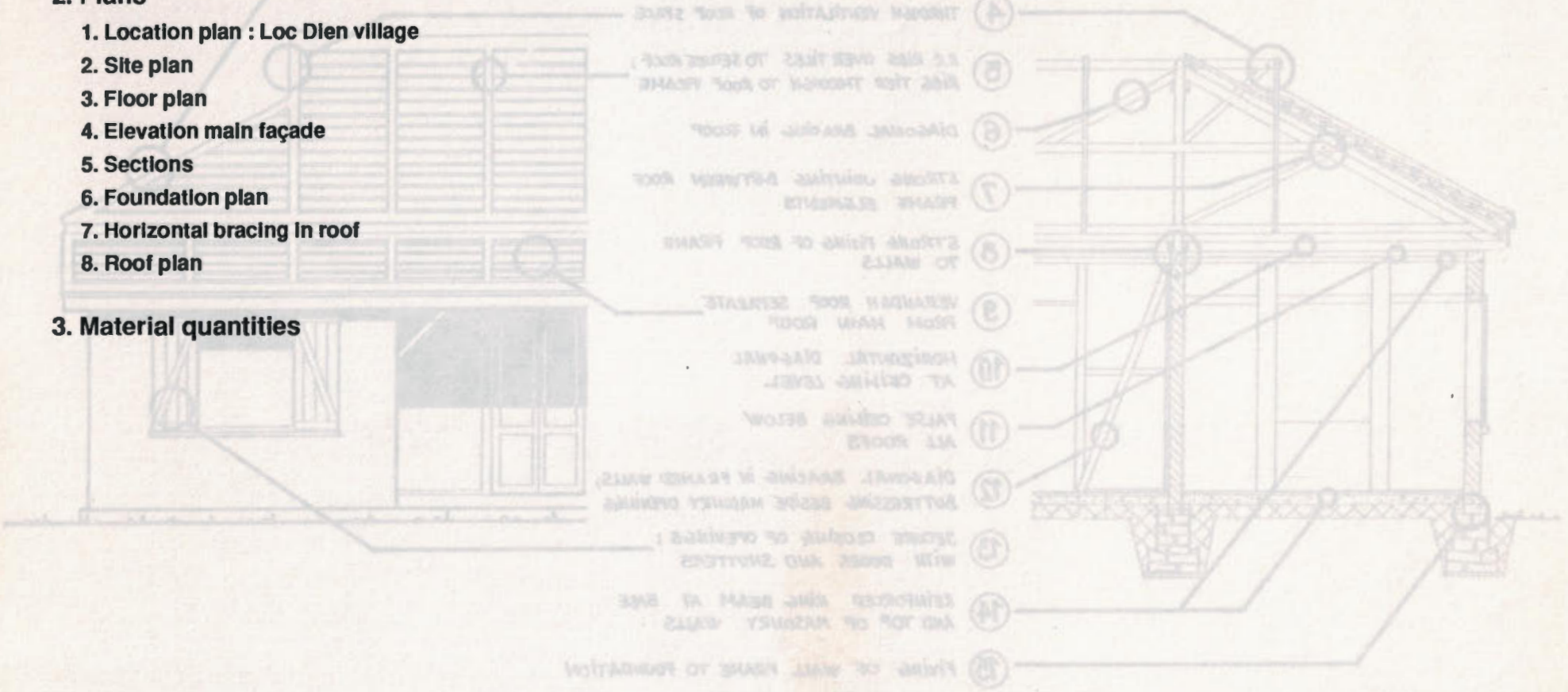
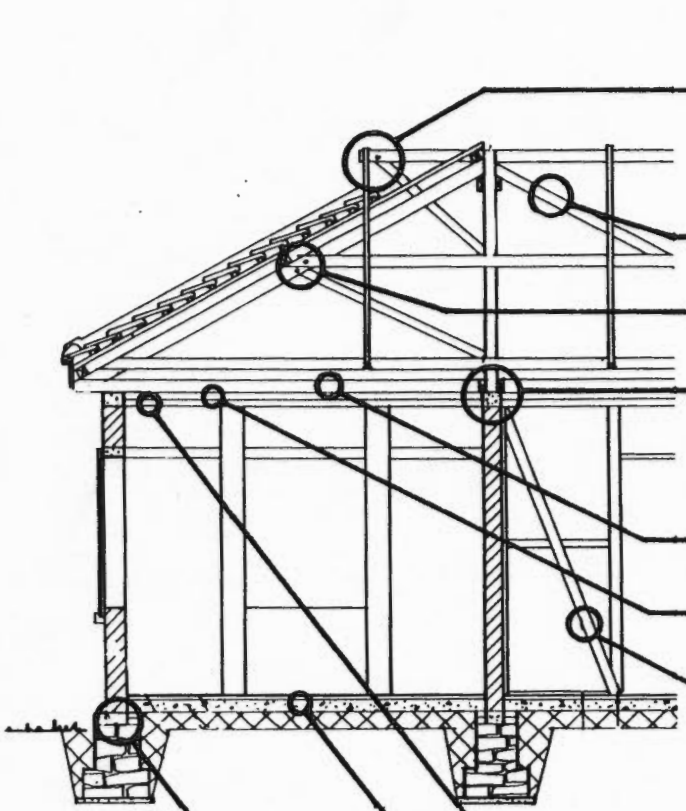
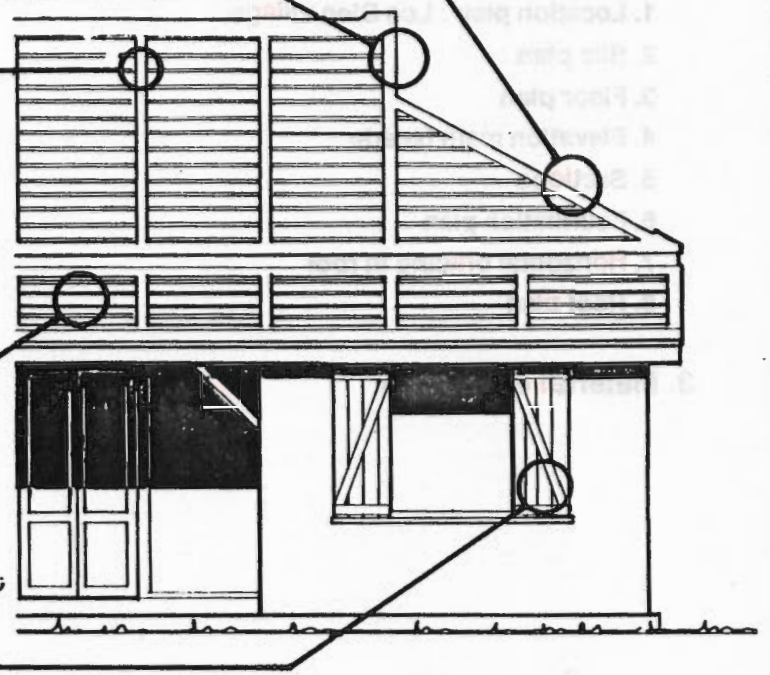
DEVELOPMENT WORKSHOP BP 10, Montayral 47500 Fumel FRANCE

SUMMARY





1. ORIENTATION AND SITING TO MINIMISE FLOOD AND WIND RISK
2. PLANTING TO PROTECT BUILDING FROM WIND AND TO PROVIDE SHADE IN SCHOOL AREA
3. HIPPED ROOF FORM AND SLOPE OF 35° TO MINIMISE WIND OBSTRUCTION AND SUCTION
4. THROUGH VENTILATION OF ROOF SPACE
5. R.C. RIBS OVER TILES TO SECURE ROOF; RIBS TIED THROUGH TO ROOF FRAME
6. DIAGONAL BRACING IN ROOF
7. STRONG JOINTING BETWEEN ROOF FRAME ELEMENTS
8. STRONG FIXING OF ROOF FRAME TO WALLS
9. VERANDAH ROOF SEPARATE FROM MAIN ROOF
10. HORIZONTAL DIAGONAL AT CEILING LEVEL
11. FALSE CEILING BELOW ALL ROOFS
12. DIAGONAL BRACING IN FRAMED WALLS; BUTTRESSING BESIDE MASONRY OPENINGS
13. SECURE CLOSING OF OPENINGS; WITH DOORS AND SHUTTERS
14. REINFORCED RING BEAM AT BASE AND TOP OF MASONRY WALLS
15. FIXING OF WALL FRAME TO FOUNDATION



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SCHOOL AT LOC DIEN, PHU LOC DISTRICT

15 CYCLONE RESISTANT DESIGN FEATURES

DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)

BINH TRI THIEN PROVINCE, VIETNAM

1. Presentation

As part of the project VIE/85/019 "Demonstration of Storm Resistant Building Techniques in Binh Tri Thien Province", the first training workshop programme includes the construction of a small school. The school, situated, at the request of the people's committee of the Phu Loc District, in Loc Dien Village, will be built by the builders and technicians participating in the workshop. It is intended that the building demonstrates the use of techniques and locally available materials wich combine to make construction more cyclone resistant.
The new school covers a total area of 120 m^2, and includes 2 classrooms measuring 7 x 5 m, and a teacher's office, creche and storeroom. It will be used by children from the fishing and farming families living in the village.
The new building in situated adjacent to two existing classroom buildings between the village houses and the main road.

THE BUILDING DESIGN

The design of the school has been developed jointly by DW/GRET with the staff of the Institute of Building Investigation and Design, Hué and the Institute of Housing and Public Building Design, Hanoi.

The siting and design of the school will highlight 15 key features of cyclone resistant design :

1. ORIENTATION AND SITING TO MINIMISE FLOOD AND WIND RISK
2. PLANTING TO PROTECT BUILDING FROM WIND AND TO PROVIDE SHADE IN SCHOOL AREA
3. HIPPED ROOF FORM AND SLOPE OF 35° TO MINIMISE WIND OBSTRUCTION AND SUCTION
4. THROUGH VENTILATION OF ROOF SPACE
5. R.C. RIBS OVER TILES TO SECURE ROOF ; RIBS TIED THROUGH TO ROOF FRAME
6. DIAGONAL BRACING IN ROOF
7. STRONG JOINTING BETWEEN ROOF FRAME ELEMENTS
8. STRONG FIXING OF ROOF FRAME TO WALLS
9. VERANDAH ROOF SEPERATE FROM MAIN ROOF
10. HORIZONTAL DIAGONAL BRACING AT CEILING LEVEL
11. FALSE CEILING BELOW ALL ROOFS
12. DIAGONAL BRACING IN FRAMED WALLS ; BUTTRESSING BESIDE MASONRY OPENINGS
13. SECURE CLOSING OF OPENINGS WITH DOORS AND SHUTTERS
14. REINFORCED RING BEAM AT BASE AND TOP OF MASONRY WALLS
15. FIXING OF WALL FRAME TO FOUNDATIONS

SPECIFICATIONS FOR THE BUILDING

The school will be built with materials which one most commonly found in the area including stone, fired bricks, lime-cement/sand blocks, reinforced concrete columns and beams, timber wall framing, torchis (wattle and daub) infill wall and ceiling panels, and fired clay roof tiles.

FOUNDATIONS

Below infill walls	stone foundation on 5 cm concrete footing
Below posts and columns	0,20 x 0,20 m reinforced concrete column bases within fired brick enclosure. Posts attached by 2 x Ø 10 diameter rebars inverted to form U loops set into the concrete.

FLOOR 5cm cement screed on 10 cm concrete sub-floor laid over hard-core base.

WALLS

Classroom walls	timber frame with diagonal bracing supporting mud / straw and sand / lime plaster on a bamboo wattle.
Office/store walls	lime-cement/sand masonry blocks.

OPENINGS

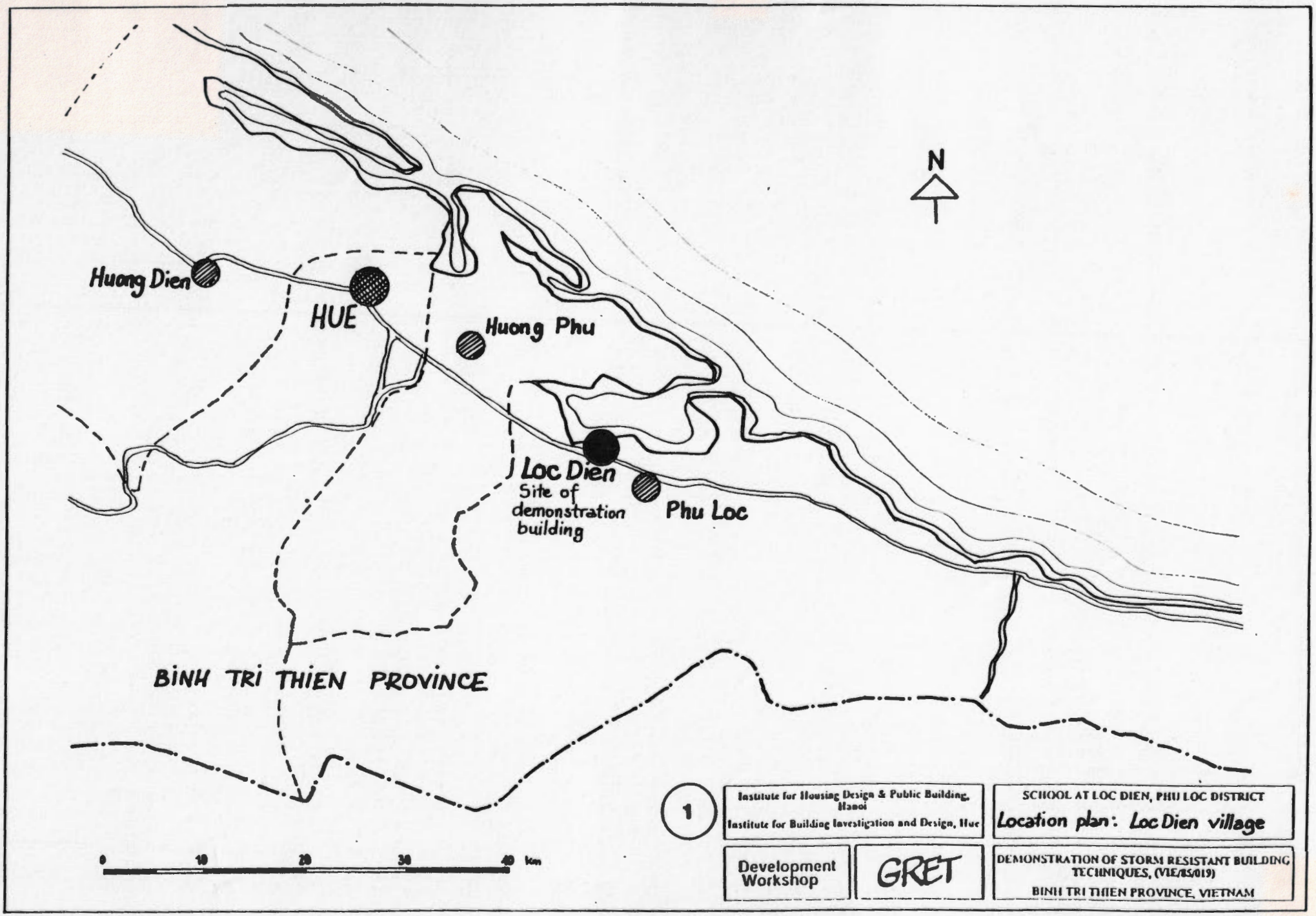
Windows	open with horizontal sliding wood shutters
Doors	double leaf full timber doors in classroms ; single leaf full timber doors in office and store.

FALSE CEILING false ceiling below all roofs - mud/straw and lime/sand plaster on bamboo wattle.

ROOF FRAME triangulated and braced timber trusses. Main roof pitch at 35^{o}, hipped roof ends. Seperate verandah roof. Minimum overhang on main roof.

ROOF COVERING machine made fired clay tiles on wood battens. Single strand reinforced concrete ribs over tiles at 1m centres and on ridges and eaves, reinforcing wire tied through at eaves and ridges to frame below.

2. Plans



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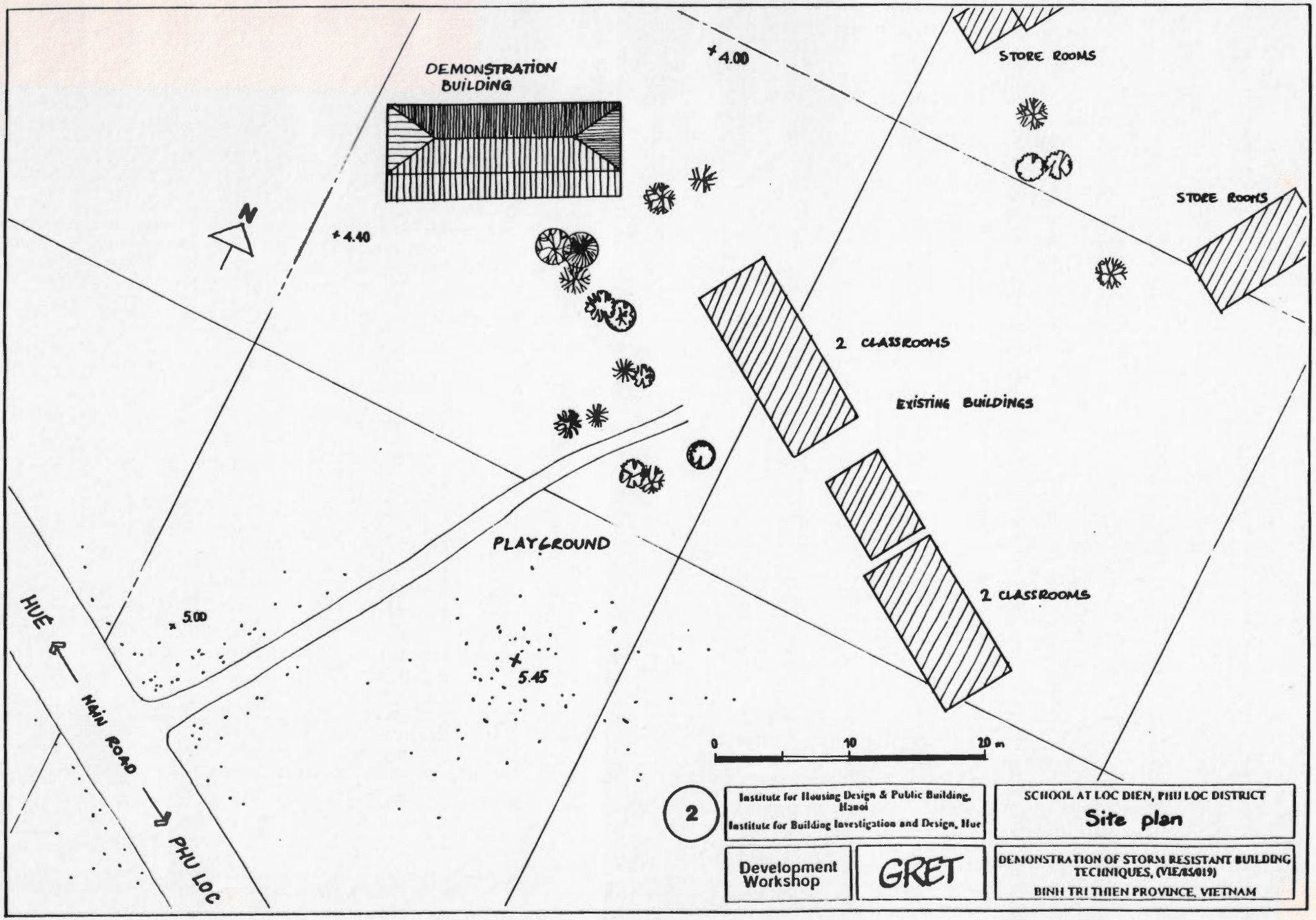
SCHOOL AT LOC DIEN, PHU LOC DISTRICT

Location plan: Loc Dien village

DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)

BINH TRI THIEN PROVINCE, VIETNAM


DEMONSTRATION BUILDING
+4.00
STORE ROOMS
STORE ROOMS
N
+4.40
2 CLASSROOMS
EXISTING BUILDINGS
PLAYGROUND
2 CLASSROOMS
HUE
MAIN ROAD
PHU LOC
+5.00
+5.45
0
10
20 m
2
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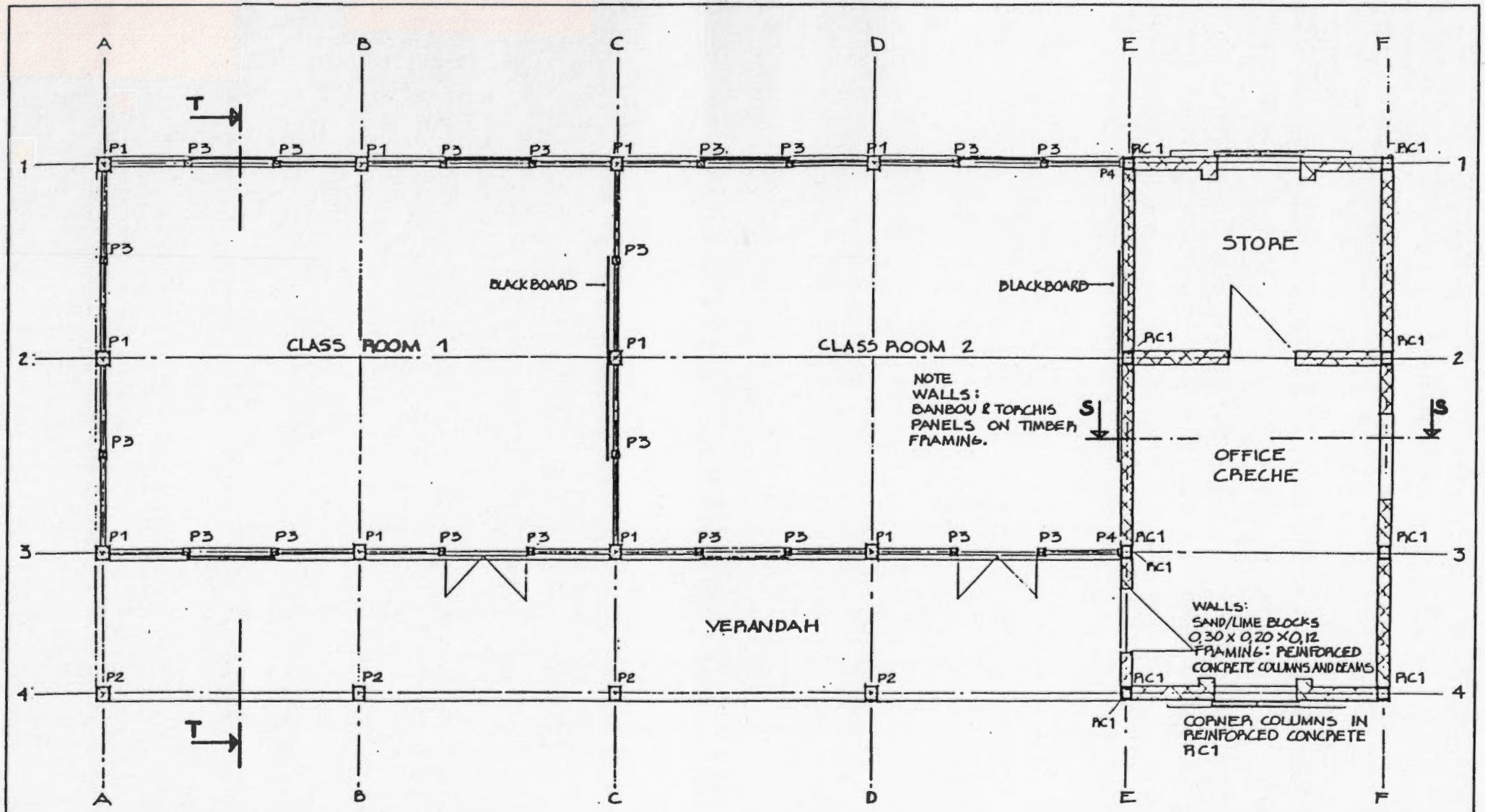
SCHOOL AT LOC DIEN, PHU LOC DISTRICT
Site plan
Development Workshop
GRET
DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)
BINH TRI THIEN PROVINCE, VIETNAM



P1 - PRIMARY TIMBER COLUMN. 3,40 X 0,18 X 0.18
P2 = VERANDAH TIMBER COLUMN 2,60 X 0,18 X 0,18
P3 = SECONDARY COLUMN 2,80 X 0,12 X 0,10
P4 = WALL BATTEN 2,80 X 0,12 X 0,05

SCALE METERS 0 1 2 3 4

3

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SCHOOL AT LOC DIEN, PHU LOC DISTRICT
Title: FLOOR PLAN
Date: 27 Feb 89 Version: 1

Development Workshop

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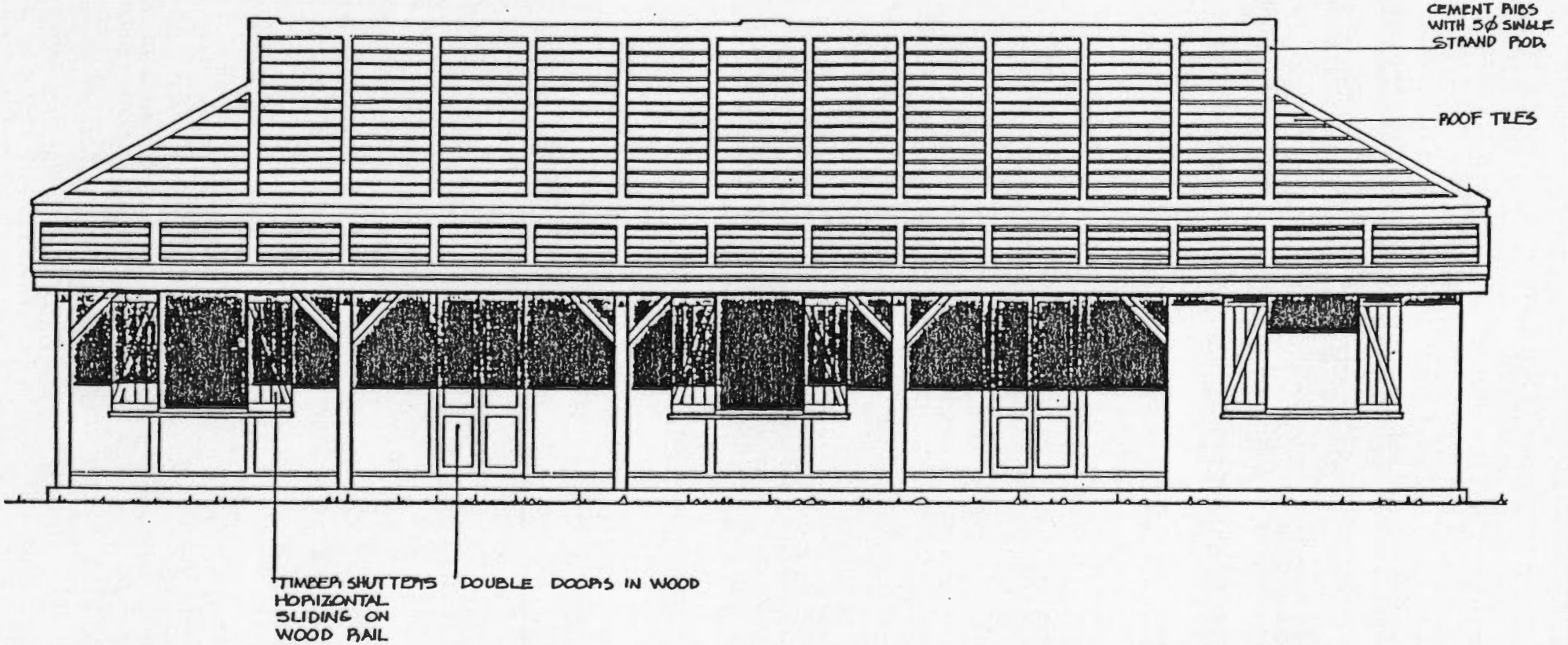
DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)
BINH TRI THIEN PROVINCE, VIETNAM



SCALE METERS 0 1 2 3 4

4

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SCHOOL AT LOC DIEN, PHU LOC DISTRICT

Title: ELEVATION MAIN FACADE

Date: 27 Feb 89 Version: 1

Development Workshop

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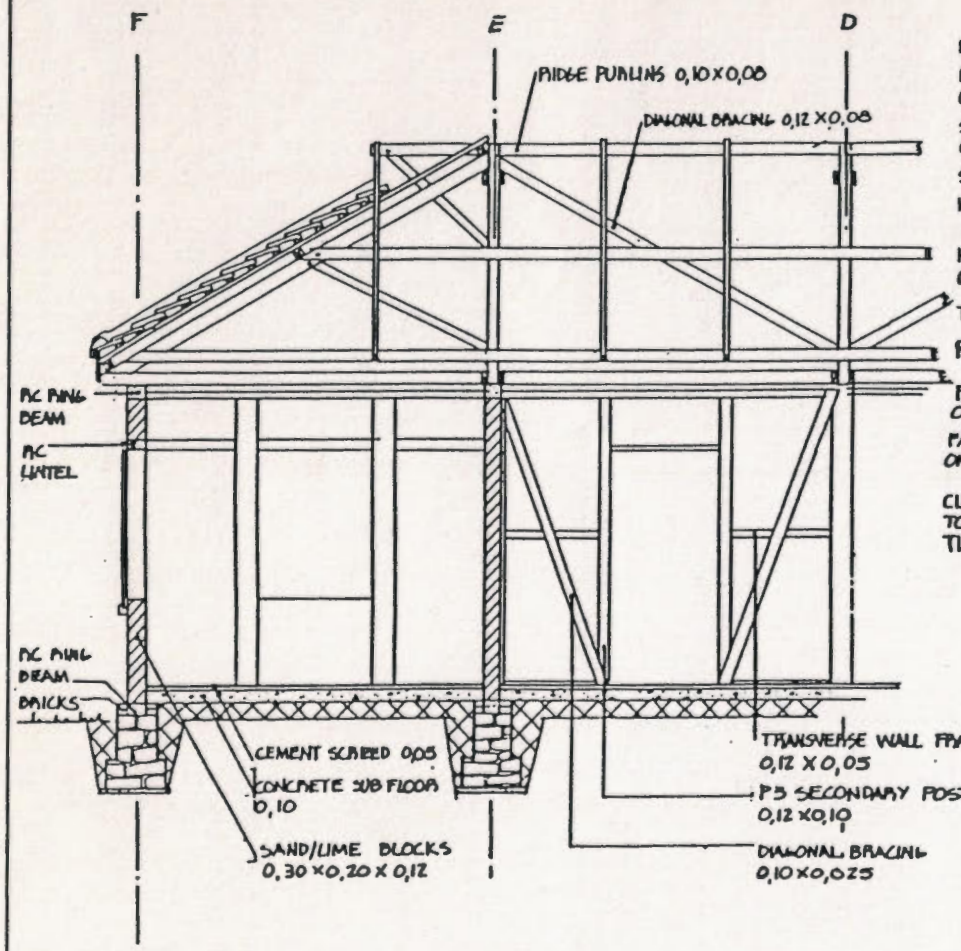
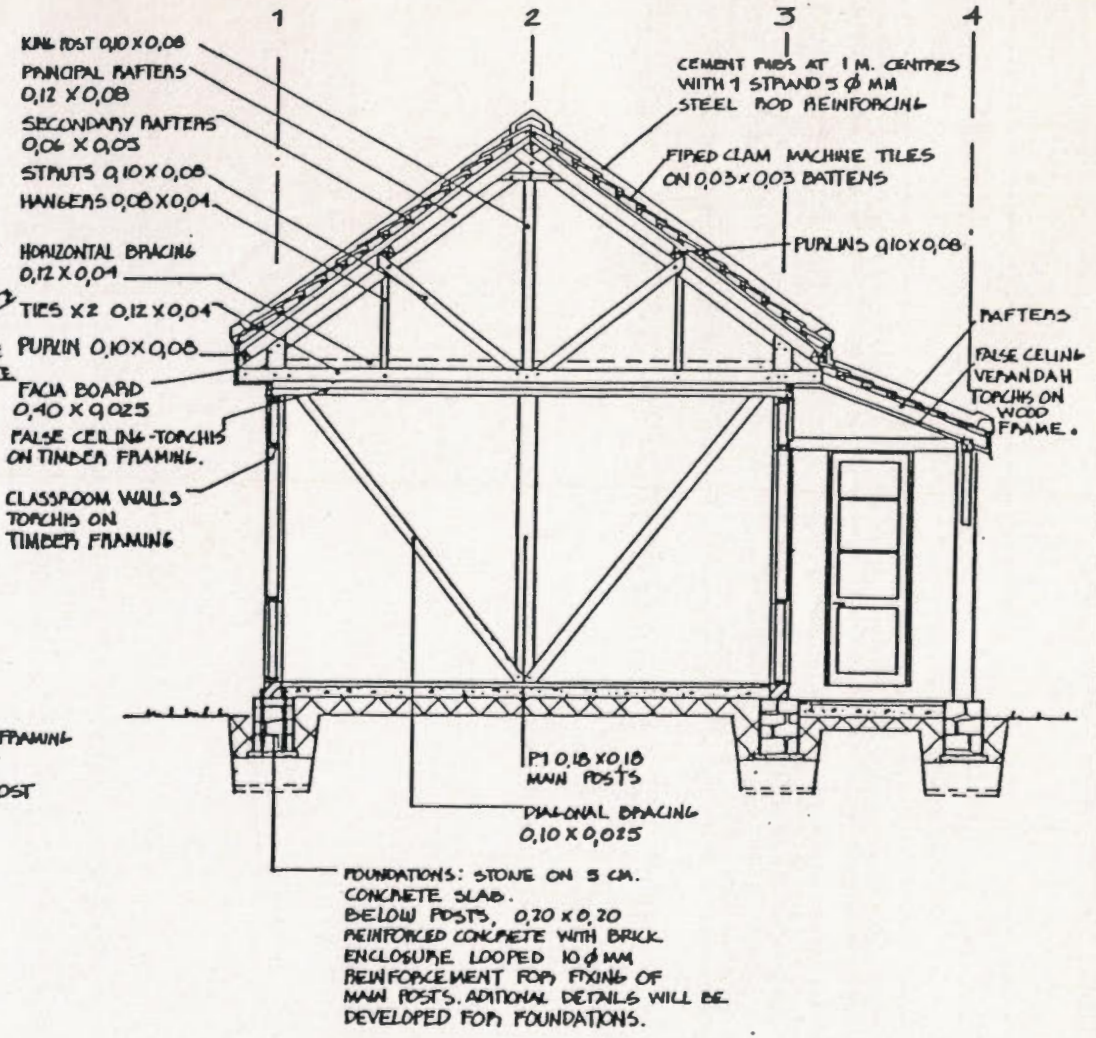
DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)

BINH TRI THIEN PROVINCE, VIETNAM



SECTION S-S



SECTION T-T

SCALE METERS 0 1 2 3 4

5

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SCHOOL AT LOC DIEN, PHU LOC DISTRICT
Title: SECTIONS
Date: 27 Feb 89 Version: 1

Development Workshop

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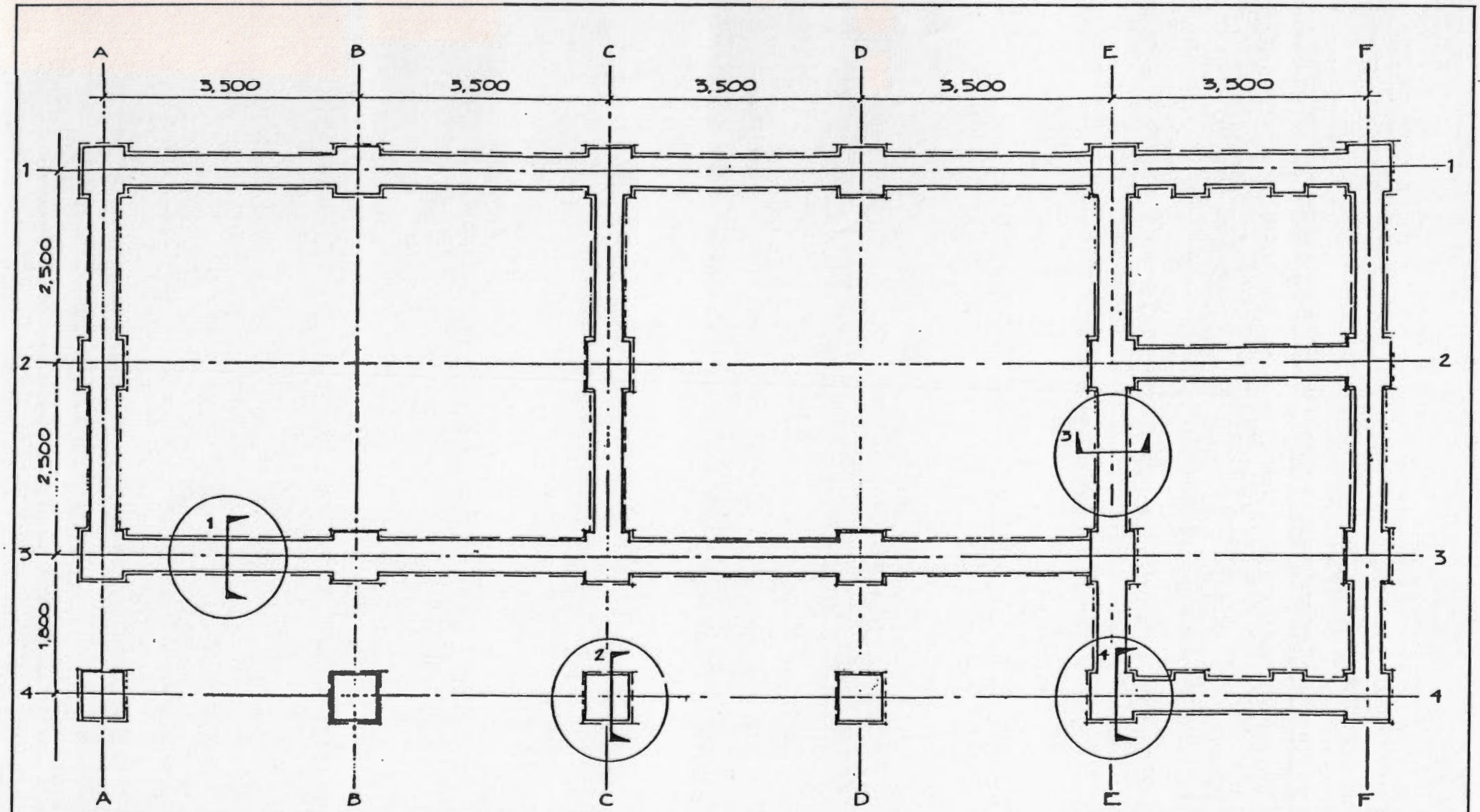
DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)
BINH TRI THIEN PROVINCE, VIETNAM



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SCHOOL AT LOC DIEN, PHU LOC DISTRICT

Title: FOUNDATION PLAN

Date: 27 Feb 89 Version: 1

Development Workshop

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DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)

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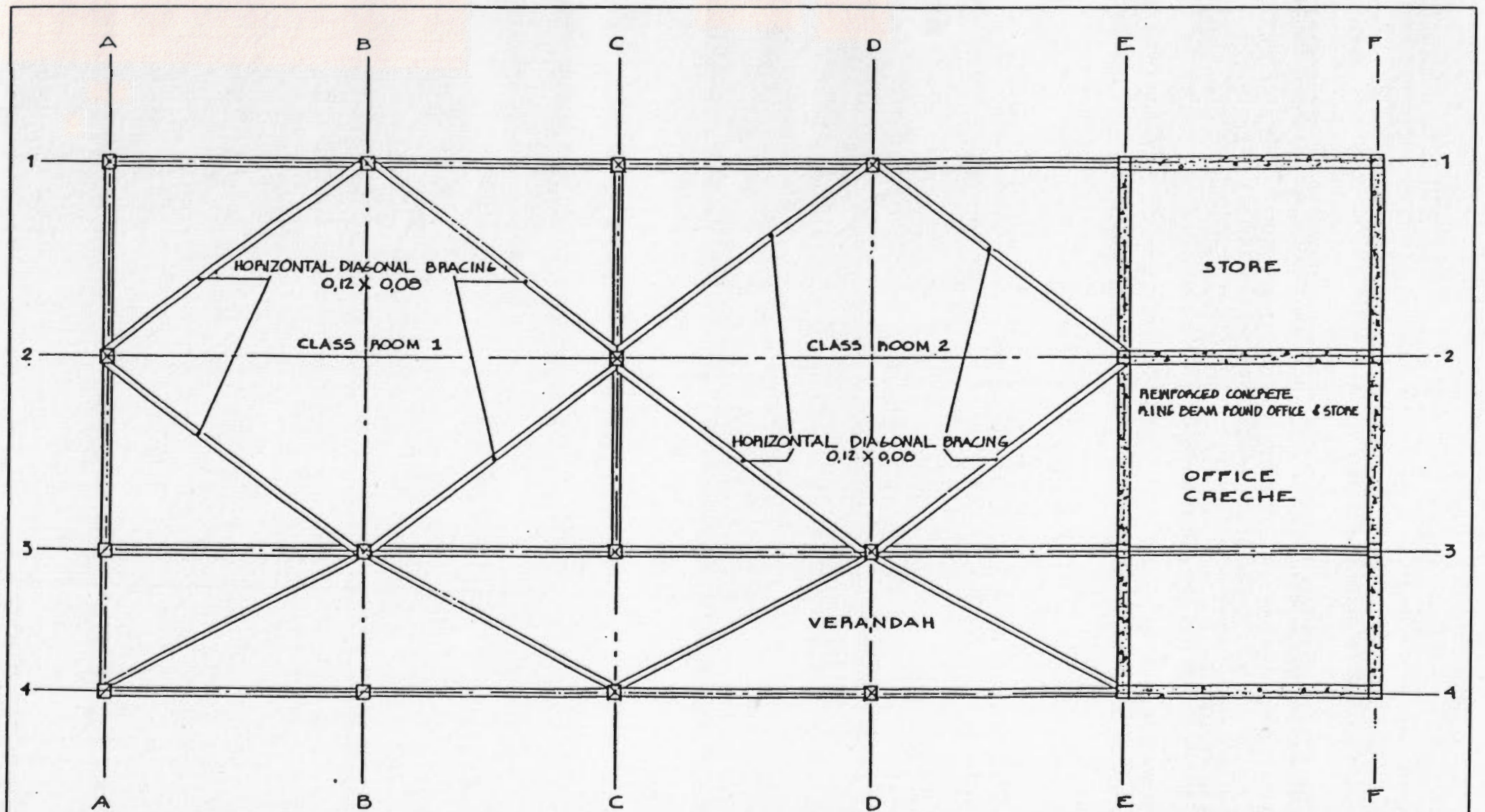

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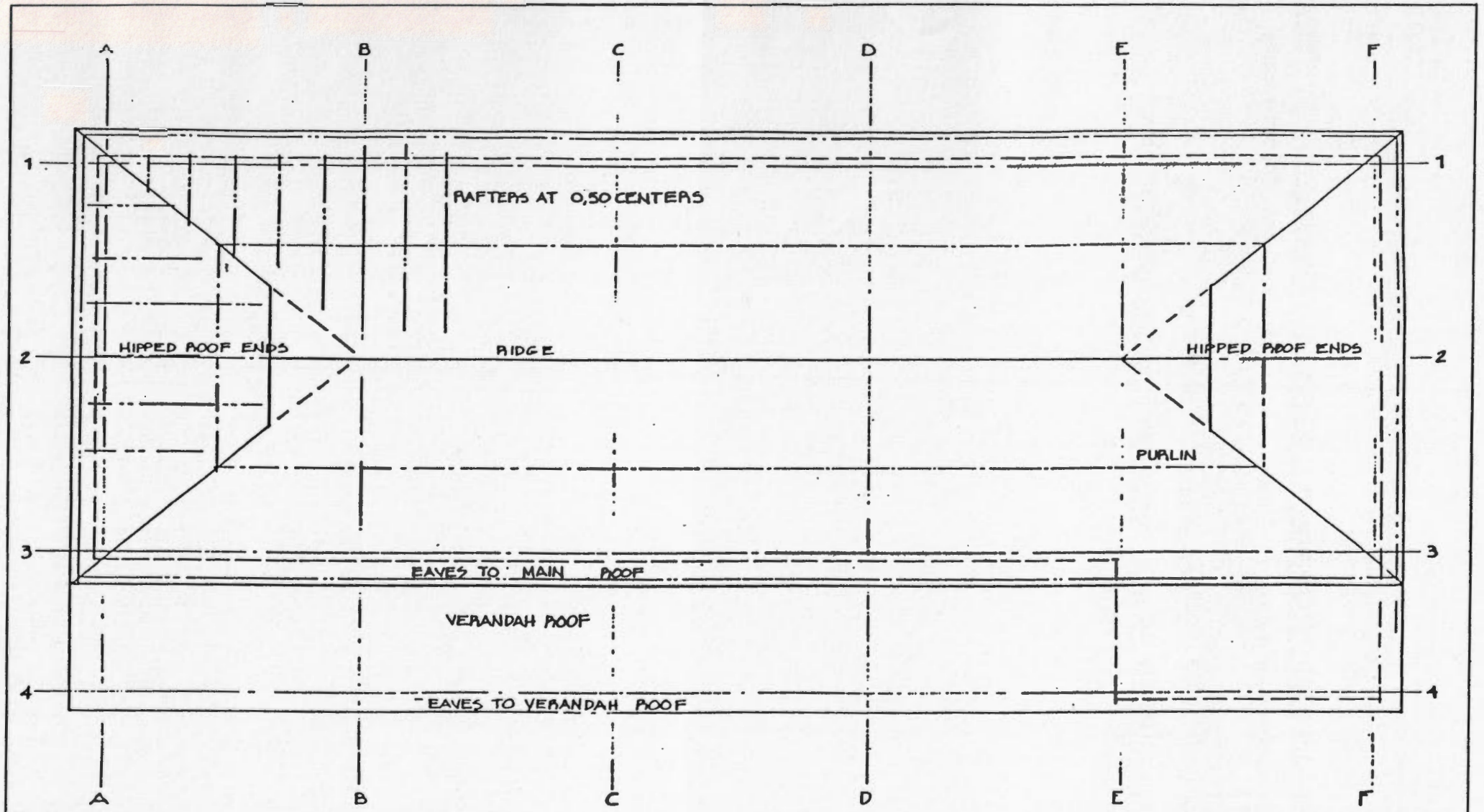
SCHOOL AT LOC DIEN, PHU LOC DISTRICT

Title: PLAN. HORIZONTAL BRACING IN ROOF

Date: 27 Feb 89 Version: 1

DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)

BINH TRI THIEN PROVINCE, VIETNAM



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SCHOOL AT LOC DIEN, PHU LOC DISTRICT

Title: ROOF PLAN

Date: 27Feb 89 Version: 1

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DEMONSTRATION OF STORM RESISTANT BUILDING TECHNIQUES, (VIE/85/019)

BINH TRI THIEN PROVINCE, VIETNAM

3. Material quantities

SCHOOL CLASSROOMS DEMONSTRATION BUILDING, LOC DIEN, PHU LOC DISTRICT .

TOTAL ORDER QUANTITIES
(rounded up)

31 m3	sand
12 m3	gravel
8 tons	cement
3 tons	lime
10.5 m3	stone
1200 bricks	
1600 sand/lime blocks	
115 kg	10mm steel bar
40 kg	8mm steel bar
20 kg	5mm steel bar
45 kg	single strand 5mm Ø reinforcing
200 m2	bamboo
680 kg	straw
15 m3	dry earth
4000 tiles	
70 ridge tiles	
2 doors 2.20 x 1.10	
2 doors 2.20 x 0.80	
9 m3	timber
160 bolts 10mm dia x 25cm	
90 kg	nails
30 m2 damp proofing	

MATERIAL QUANTITIES - CALCULATION	ORDER QUANTITIES
1. FOUNDATIONS	
1A : 5 cm concrete footing	
depth x length x width x number = total m3	
(a) under columns	
0.05 0.70 0.70 22 0.539	
(b) below side walls	
0.05 2.80 0.50 11 0.770	
(c) transverse walls	
0.05 1.80 0.50 8 0.360	
(d) extra below buttresses	
0.05 0.50 0.15 4 0.015	
(e) below entrance and facing wall in office	
0.05 1.10 0.50 2 0.055	
total 1.739	
materials: sand/m3 0.40 m3	0.7 m3 sand
gravel/m3 0.80 m3	1.4 m3 gravel
cement/m3 200 kg	347.8 kg cement
1B : Stone foundation	
Note: In all foundations except below torchis walls in classroom.	
depth x length x width x number = total m3	
(a) under columns	
0.30 0.60 0.60 22 2.376	
(b) side walls, office	
0.30 2.90 0.40 3 1.044	
(c) transverse walls, office	
0.30 1.90 0.40 4 0.912	
(d) extra below buttresses	
0.30 0.40 0.10 4 0.048	
(e) below entrance and facing wall in office	
0.30 1.20 0.40 2 0.288	
total 4.668	
materials: stone (3 parts) 3.501	3.5 m3 stone
mortar (1 part) 1.167	
sand/m3 1.10 m3	1.3 m3 sand
cement/m3 300 kg	350.1 kg cement

MATERIAL QUANTITIES - CALCULATION	ORDER QUANTITIES
1C : Foundations level 2	
Note: Including reinforced concrete below columns and ring beam. Calculation: subtract brick and RC ring beam layer in office (T1-T2)	
depth x length x width x number = total m3	
(a) side walls	
0.50 2.90 0.40 11 6.380	
(b) transverse walls	
0.50 1.90 0.40 8 3.040	
(c) below buttress	
0.50 0.40 0.10 4 0.080	
(d) below office entrance and facing wall	
0.50 1.20 0.40 2 0.480	
sub-total (T1) 9.980	
Office ring beam	
depth x length x width x number = total m3	
(a) side walls	
0.10 2.90 0.40 3 0.348	
(b) transverse walls	
0.10 1.90 0.40 4 0.304	
(c) below buttress	
0.10 0.40 0.10 4 0.016	
(d) office entrance and facing wall	
0.10 1.20 0.40 2 0.096	
sub-total (T2) 0.764	
net total (T1 - T2) 9.216	
materials: stone (3 parts) 6.912	6.9 m3 stone
mortar (1 part) 2.304	
sand/m3 1.10 m3	2.5 m3 sand
cement/m3 300 kg	691.2 kg cement

SCHOOL CLASSROOMS DEMONSTRATION BUILDING, LOC DIEN, PHU LOC DISTRICT contd.

MATERIAL QUANTITIES - CALCULATION				ORDER QUANTITIES
1D : Office ring beam				
Note: bricks 20 x 10 x 5 cm				
bricks/mortar 50% of 0.764 (see 1C)			0.382	
materials	bricks (3 parts)		0.287	287 bricks
	mortar (1 part)		0.096	
	sand/m3	1.10 m3		0.1 m3 sand
	cement/m3	300 kg		28.7 kg cement
concrete 50% of 0.764 (see 1C)			0.382	
materials	sand/m3	0.40 m3		0.2 m3 sand
	gravel/m3	0.80 m3		0.3 m3 gravel
	cement/m3	300 kg		114.6 kg cement
Reinforcement in ring beam				
	length	x number	x kg	
(a) side walls (8mm steel)	4.00	6 (3 x 2)	0.395	9.5 kg 8mm steel bar
(b) transverse walls (8mm steel)	7.50	4 (2 x 2)	0.395	11.9 kg 8mm steel bar
(c) links @ 30cm centres (5mm steel)	0.10	78 (42 + 36)	0.154	1.2 kg 5mm steel bar
1E : Damp proof course (bitumen)				
Level 2 foundation surface area (see 1C) -				
		27.6 m2		27.6 m2 bitumen

MATERIAL QUANTITIES - CALCULATION					ORDER QUANTITIES
1F : Foundation column bases					
Note: Calculated by deduction from total volume of column base.					
	depth	x length	x width	x number = total m3	
(i) total volume	0.50	0.40	0.40	22 1.760	
(ii) concrete in column bases	0.50	0.20	0.20	22 0.440	
(iii) reduction - ring beam (calculated in 1D)	0.10	0.40	0.40	8 0.128	
(a) concrete in column bases see (ii) above				0.440	
materials	sand/m3	0.40 m3			0.2 m3 sand
	gravel/m3	0.80 m3			0.4 m3 gravel
	cement/m3	300 kg			132.0 kg cement
(b) bricks used as shuttering					
Note: bricks 20 x 10 x 5 cm					
use (i), less (ii) + (iii)				1.192	
materials	bricks	(3 parts)		0.894	894 bricks
	mortar	(1 part)		0.298	
	sand/m3	1.10 m3			0.3 m3 sand
	cement/m3	300 kg			89.4 kg cement
Reinforcement					
	length	x number	x kg		
(a) fixing of timber columns to foundations (2 per column) (10mm steel)	1.40	28 (14 x 2)	0.617		24.2 kg 10mm steel bar
(b) starter bars for base to RC columns in office (10mm steel)	1.40	32 (8 x 4)	0.617		27.6 kg 10mm steel bar
(c) links @ 30cm centres (5mm steel)	0.60	32 (8 x 4)	0.154		3.0 kg 5mm steel bar

SCHOOL CLASSROOMS DEMONSTRATION BUILDING, LOC DIEN, PHU LOC DISTRICT contd.

MATERIAL QUANTITIES - CALCULATION | ORDER QUANTITIES

2. FLOORS

2A : Concrete sub floor

	depth	x length	x width	= total m3	
(a) class 1					
	0.10	6.80	4.80	3.264	
(b) class 2					
	0.10	6.80	4.80	3.264	
(c) office					
	0.10	3.30	2.30	0.759	
(d) store					
	0.10	3.30	4.10	1.353	
(e) verandah					
	0.10	14.00	1.80	2.520	
total				11.160	
materials	sand/m3	0.40 m3			4.5 m3 sand
	gravel/m3	0.80 m3			8.9 m3 gravel
	cement/m3	200 kg			2232.0 kg cement

2B : Sand cement screed (option)

	depth	x length	x width	= total m3	
(a) class 1					
	0.05	6.80	4.80	1.632	
(b) class 2					
	0.05	6.80	4.80	1.632	
(c) office					
	0.05	3.30	2.30	0.380	
(d) store					
	0.05	3.30	4.10	0.677	
(e) verandah					
	0.05	14.00	1.80	1.260	
total				5.580	
materials	sand/m3	1.10 m3			6.1 m3 sand
	cement/m3	300 kg			1674.0 kg cement

MATERIAL QUANTITIES - CALCULATION | ORDER QUANTITIES

3. WALLS

Note: blocks 30 x 20 x 12 cm

3A : Blockwork below frame walls

	length	x number	+ length	x number	= m. length	
	3.3	8	2.8	4	37.60	125 blocks
					total m3	
	mortar				0.24	
	sand/m3	1.10 m3				0.3 m3 sand
	cement/m3	300 kg				79 kg cement

3B : Blockwork office walls

Wall area less openings

	height	x length	(-	openings m2)	= total m2	
	2.8	26		8	64.80	1446 blocks
					total m3	
	mortar	(146 x 0.2)/4 =			3.24	
	sand/m3	1.10 m3				3.6 m3 sand
	cement/m3	300 kg				972 kg cement

3C : RC columns in office

	height	x length	x width	x number	= total m3	
(a) concrete						
	2.95	0.20	0.20	6	0.708	
	2.45	0.20	0.20	2	0.196	
(b) lower ring beam and lintels						
	1.50	0.20	0.15	2	0.090	
	6.60	0.20	0.15	1	0.198	
(c) main ring beam						
	13.10	0.20	0.15	1	0.393	
total					1.585	
materials	sand/m3	0.40 m3				0.6 m3 sand
	gravel/m3	0.80 m3				1.3 m3 gravel
	cement/m3	300 kg				475.5 kg cement

SCHOOL CLASSROOMS DEMONSTRATION BUILDING, LOC OIEN, PHU LOC DISTRICT contd.

MATERIAL QUANTITIES - CALCULATION				ORDER QUANTITIES
reinforcement				
	length	x number	x kg	
(a) columns				
(10mm steel)	3.25	24	0.617	48.1 kg 10mm steel bar
	2.75	8	0.617	13.6 kg 10mm steel bar
(b) ring beam				
(8mm steel)	22.70	2	0.395	17.9 kg 8mm steel bar
(c) links @ 30cm centres				
(5mm steel)	0.60	60	0.154	5.5 kg 5mm steel bar
	0.60	16	0.154	1.5 kg 5mm steel bar
	0.60	75	0.154	6.9 kg 5mm steel bar
3D : "Torchis" walls				
Surface area = 78.25 m2				
bamboo wattle				80.0 m2 bamboo (already ordered)
mud/straw plaster				
surface area x depth = m3				
80	0.05	4		
straw/m3	70 kg			280.0 kg straw
clay/m3	1.5 m3 dry earth			6.0 m3 dry earth
lime/sand plaster				
2 layers @ 80m2 x 2cm = m3				
160	0.02	3.2		
1 layer @ 80m2 x 1cm = m3				
80	0.01	0.8		
total lime/sand		4.0		
sand/m3	1.1 m3			4.4 m3 sand
lime/m3	350 kg			1400.0 kg lime

MATERIAL QUANTITIES - CALCULATION					ORDER QUANTITIES
3E : Wall framework - vertical elements					
	length	x width	x depth	x number = total m3	TIMBER
(a) main posts (P1)					
	3.40	0.18	0.18	10 1.102	10 posts 3.4 x 0.18 x 0.18
(b) verandah posts (P2)					
	2.60	0.18	0.18	4 0.337	4 posts 2.6 x 0.18 x 0.18
(c) secondary posts (P3)					
	2.80	0.12	0.10	18 0.605	18 posts 2.8 x 0.12 x 0.10
(d) wall batten (P4)					
	2.80	0.12	0.05	3 0.050	3 posts 2.8 x 0.12 x 0.05
total				2.094	
3F : Wall framework - horizontal elements					
Note: See detail for identification of elements					
	length	x width	x depth	x number = total m3	
(a) floor plates (see detail in doorway)					
	3.30	0.12	0.05	8 0.158	8 plates 3.3 x 0.12 x 0.05
(b) floor plates (transverse walls)					
	2.80	0.12	0.05	4 0.067	4 plates 2.8 x 0.12 x 0.05
(c) horizontal framing for "torchis"					
side panel					
	1.00	0.12	0.05	16 0.096	16 posts 1.0 x 0.12 x 0.05
panel with opening					
	1.20	0.12	0.05	14 0.101	14 posts 1.2 x 0.12 x 0.05
transverse wall framing					
	1.10	0.12	0.05	16 0.106	16 posts 1.1 x 0.12 x 0.05
(d) secondary wall plates below roof frame					
	3.30	0.12	0.025	8 0.079	8 plates 3.3 x 0.12 x 0.025
	2.80	0.12	0.025	4 0.034	4 plates 2.8 x 0.12 x 0.025
(d) primary wall plates below roof frame					
side walls					
	3.30	0.12	0.05	8 0.158	8 plates 3.3 x 0.12 x 0.05
transverse walls					
	2.80	0.12	0.05	4 0.067	4 plates 2.8 x 0.12 x 0.05
verandah					
	3.30	0.15	0.05	4 0.099	4 plates 3.3 x 0.15 x 0.05
diagonal struts below verandah					
	0.95	0.10	0.08	8 0.061	8 plates 0.95 x 0.10 x 0.08
total				1.0262	

SCHOOL CLASSROOMS DEMONSTRATION BUILDING, LOC DIEN, PHU LOC DISTRICT contd.

MATERIAL QUANTITIES - CALCULATION						ORDER QUANTITIES
3G : Bracing in walls						
Note: See sections						
	length	x width	x depth	x number	= total m3	TIMBER
(a) bracing on side walls	3.20	0.10	0.025	16	0.128	16 braces 3.2 x 0.10 x 0.025
(b) bracing on transverse walls	3.80	0.12	0.025	4	0.046	4 braces 3.8 x 0.12 x 0.025
total					0.174	
4. ROOF FRAME						
4A : Primary trusses						
	length	x height	x width	x number	= total m3	
(a) ties (2 per truss)	5.75	0.12	0.04	8	0.221	8 ties 5.75 x 0.12 x 0.04
(b) principal rafter (2 per truss)	3.75	0.12	0.08	8	0.288	8 rafters 3.75 x 0.12 x 0.08
(c) king post	2.00	0.10	0.08	4	0.064	4 posts 2.00 x 0.10 x 0.08
(d) hangers	1.25	0.08	0.04	8	0.032	8 hangers 1.25 x 0.08 x 0.04
(e) struts	2.00	0.10	0.08	8	0.128	8 struts 2.00 x 0.10 x 0.08
(f) ridge ties (2 per truss)	0.70	0.08	0.04	8	0.018	8 ties 0.70 x 0.08 x 0.04
total					0.751	
4B : Secondary truss on hip ends						
	length	x height	x width	x number	= total m3	
(a) diagonal rafters to corners	5.30	0.12	0.08	4	0.204	4 rafters 5.3 x 0.12 x 0.08
(b) central rafter	4.40	0.12	0.08	2	0.084	2 rafters 4.4 x 0.12 x 0.08
(c) struts from diagonal rafters	2.50	0.10	0.08	4	0.080	4 struts 2.50 x 0.10 x 0.08
(d) ties to corners	4.90	0.12	0.04	8	0.188	8 ties 4.90 x 0.12 x 0.04
total					0.556	

MATERIAL QUANTITIES - CALCULATION						ORDER QUANTITIES
4C : Purlins and ridge						
	length	x height	x width	x number	= total m3	TIMBER
(a) ridge	13.00	0.10	0.08	2	0.208	2 ridges 13.0 x 0.10 x 0.08
(b) purlins	14.50	0.10	0.08	2	0.232	2 purlins 14.5 x 0.10 x 0.08
	3.00	0.10	0.08	2	0.048	2 purlins 3.0 x 0.10 x 0.08
(c) purlins at eaves (main roof)	18.20	0.10	0.08	4	0.582	4 purlins 18.2 x 0.10 x 0.08
	5.70	0.10	0.08	4	0.182	4 purlins 5.7 x 0.10 x 0.08
total					1.253	
4D : Main roof						
	length	x height	x width	x number	= total m3	
(a) rafters	3.50	0.06	0.05	48	0.504	48 rafters 3.5 x 0.06 x 0.05
	4.40	0.06	0.05	8	0.106	8 rafters 4.4 x 0.06 x 0.05
(b) battens (calculated as 18.4 x 15 x 2)	555.00	0.03	0.03		0.500	555 m battens 0.03 x 0.03
(c) facia board	30.20	0.40	0.025		0.302	1 board 30.2 x 0.40 x 0.025
	18.40	0.25	0.025		0.115	1 board 18.4 x 0.25 x 0.025
total					1.526	
4E : Verandah and office extension						
	length	x height	x width	x number	= total m3	
(a) rafters	2.00	0.12	0.08	16	0.307	16 rafters 2.0 x 0.12 x 0.08
(b) battens (calculated as 18.4 x 8)	150.00	0.03	0.03		0.135	150 m battens 0.03 x 0.03
(c) facia board	18.40	0.25	0.025	1	0.115	1 board 18.40 x 0.25 x 0.025
	1.70	0.25	0.025	2	0.021	2 boards 1.70 x 0.25 x 0.025
total					0.578	

MATERIAL QUANTITIES - CALCULATION						ORDER QUANTITIES
4F : Diagonal bracing in roof/hangers						
	length	x height	x width	x number	= total m3	TIMBER
(a) diagonal bracing in roof	4.00	0.12	0.08	3	0.115	3 braces 4.0 x 0.12 x 0.08
(b) horizontal bracing in roof	4.80	0.12	0.04	6	0.138	6 braces 4.8 x 0.12 x 0.04
(c) hangers	1.25	0.08	0.04	6	0.024	6 hangers 1.25 x 0.08 x 0.04
(d) horizontal bracing in verandah	4.00	0.12	0.04	4	0.077	4 braces 4.00 x 0.12 x 0.08
total					0.354	
5. ROOF COVERING						
5A : Tiles	rows	x length	= total m			
	35	18.5	647.5			
tiles/m	6		=		3885	4000 tiles
5B : Ridges			total m			
			27.0			
ridge tiles/m	2.5		=		67.5	70 ridge tiles
5C : Cement	length	x width	x height	x number	= total m3	
(a) ribs	3.50	0.12	0.10	24	1.008	
	4.40	0.12	0.10	4	0.211	
(b) ridges	27	0.12	0.10		0.324	
total					1.543	
sand/m3	1.10 m3					1.7 m3 sand
cement/m3	300 kg					463.0 kg cement
5D : Reinforcing bar in roof ribs (single strand 5mm diameter)	length	x kg	x number	= total kg		
(a) vertical ribs	3.5	0.154	38	20.482		
(b) horizontal ribs	18.5	0.154	5	14.245		
(c) verandah (vertical)	2.0	0.154	16	4.928		
total				39.655		
			x	1.1		
total + 10%				43.621		43.6 kg single strand 5mm rod

MATERIAL QUANTITIES - CALCULATION						ORDER QUANTITIES
6. FALSE CEILING						
6A : Ceiling joists	length	x depth	x width	x number	= m3	TIMBER
	5.00	0.06	0.05	10	0.150	10 joists 5.00 x 0.06 x 0.05
	17.30	0.06	0.05	3	0.156	3 joists 17.30 x 0.06 x 0.05
	2.00	0.06	0.05	16	0.096	16 joists 2.00 x 0.06 x 0.05
total					0.4017	
6B : Ceiling					m2	
(a) rooms					86	
(b) verandah					28	
total					114	114 m2 bamboo (already ordered)
6C : Clay/straw infill	surface area	x depth	= m3			
	114	0.05	5.7			
straw/m3	70 kg					399.0 kg straw
clay/m3	1.5 m3 dry earth					8.6 m3 dry earth
6D : Lime/sand plaster						
	2 layers @ 114m2	x 2cm	= m3			
	228	0.02	4.56			
total lime/sand			4.56			
sand/m3	1.1 m3					5.0 m3 sand
lime/m3	350 kg					1596.0 kg lime

SCHOOL CLASSROOMS DEMONSTRATION BUILDING, LOC DIEN, PHU LOC DISTRICT contd.

MATERIAL QUANTITIES - CALCULATION	ORDER QUANTITIES
7. OPENINGS	
7A : Window shutters	
(a) shutters for 9 windows (2 horizontal sliding panels)	
height x width x depth x number = total m3	
1.60 x 1.20 x 0.02 x 9 = 0.346	9 shutters 1.60 x 1.20 x 0.02
(b) bracing	
length x width x depth	
25.8 x 0.10 x 0.02 = 0.052	25.8 m braces 0.10 x 0.02
(c) rails	
length x height x depth x number	
2.3 x 0.08 x 0.05 x 18 = 0.166	18 rails 2.3 x 0.08 x 0.05
total 0.563	
7B : Ironmongery	
To be designed/purchased during workshop.	
7C : Doors	
height x width x number	
(a) double doors	
2.20 x 1.10 x 2	2 doors 2.20 x 1.10
(b) single doors	
2.20 x 0.80 x 2	2 doors 2.20 x 0.80
8. MISCELLANEOUS	
8A : bolts	
160 bolts 10 mm x 25 cm	160 bolts 10mm diameter x 25cm
8B : nails	
90 kg	90 kg nails