PRIMARY SCHOOL BUILDINGS
for
FLOODED AREAS
in
BANGLADESH

A REPORT OF AN INTERNSHIP

Unesco Principal Regional Office for Asia and the Pacific
August 1988

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This is a report of an internship and is not to be considered as a final design. Exact details will be worked out in the process of the project execution.

by Mr. Abdus Salim, architect

Mr. Md. Ahad Ali, engineer

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PREFACE

During July to September 1987 Bangladesh experienced devastating flooding. Crops, livestock, homes and physical infrastructure all suffered substantial damages from the high water level of the rivers. Educational institutions, like all other sectors, were severely affected.

When the Assistant Director General for Coordination of Unesco Activities in Asia and the Pacific visited Bangladesh in August, the Bangladesh government appealed for assistance from Unesco. A technical mission from Unesco visited the country in September and was provided a copy of the preliminary report prepared by the Ministry of Education. Based on the government's findings a report was sent to the Director-General of Unesco which recommended that assistance be given for the design of school buildings which could be adapted to serve as community shelters. Funding for construction of a prototype was also foreseen.

The newly installed Director General granted a sum of $16,000 for the activity and cited this action in his inaugural speech as an example of the kind of practical action Unesco can take to be of concrete help to Member States faced with emergency situations.

Under that assistance two persons from the Facilities Department, Ministry of Education were provided with internship with the Educational Facilities Development Service of the Unesco Principal Regional Office for Asia and the Pacific. Mr. Abdus Salim, assistant architect is a member of the architecture section of the Facilities Department. He was also co-author of the 1981 study "Alternative building designs for Universal primary education in Bangladesh: A report on an in-service training activity" which was also the product of an internship at Unesco Bangkok. Mr. Md. Ahad Ali, is an assistant engineer in the planning and design section. This was his first contact with Unesco.

Special appreciation is given to Mr. Hedayet Ahmed, Secretary of Education, Bangladesh, who met with the team in Bangkok and gave valuable guidance. The study of flood damage prepared under the leadership of Mr. A.M.A. Rashid, Chief of the Monitoring Cell, Ministry of Education, has been an invaluable source of data to make clear the nature of the problem being faced. Finally Mr. Delware Hussain, Director of the Facilities Department is to be thanked for having made the internship possible and for his commitment to follow up this study with the large scale implementation of the new designs.

CHAPTER ONE: THE PROBLEM

Floods are an annual occurance in Bangladesh; what is not predictable is where they will occur and how long they will last.

In the past Unesco and other international organizations have given great attention the problems of coastal flooding. These floods are brought by typhoons and raise for designers difficult questions about how to deal with scouring of foundations and strong forces caused by waves striking the buildings. There are also special sociological problems about using these structures as shelters since people are reluctant to abandon their recently claimed land to seek the safety of a refuge. Annexes 1A through E contain the drawings of five designs that have been prepared to deal with this type of flooding.

The current study, however, is attacking a different problem: that of flooding from rains and high rivers. The maps in Figures 1, 2 and 3 explain more eloquently than words just how much of the land area is subjected to flooding and the source of these floods. In 1987 the floods reached record levels and covered a large part of the country.

The damages to educational buildings were extensive. The following description is adapted from the report School maps of flood damaged educational institutions 1987 published by the Ministry of Education, Dhaka in January 1988.

> "The 1987 flood had devastating effects in Bangladesh destroying crops, cattle, homesteads, physical infrastructure and educational institutions. The sudden onrush of flood water caused serious damage to poorly made Katcha structures of schools. Education in rural areas came almost to a halt due to this.
>
> Educational institutions are damaged by floods in two ways; by the flood waters themselves and by the wear and tear resulting from their being used as refuge centres by displaced persons. It is known that one major type of damage is the loss of furniture, much of which is apparently used as fire-wood (*). In addition there are damages to the building finishes and sanitary facilities.
>
> One of the most severe damages caused to the educational system due to flood is the loss of education of Bangladesh's millions of pupils. No amount of external aid Government spending can compensate this loss. Any serious examination of disaster preparedness should consider to avoid such losses in the future."
>
> (*) This is necessary for the stranded people to survive.

In June 1985 the Facilities Department had published School maps on primary education in Bangladesh which for the first time gave a comprehensive picture of the current stock of buildings for primary education in Bangladesh. This data based provided a foundation on which to undertake a survey of damages to schools. The study of the damages comprises nine volumes: one summary volume and one each covering the eight zones of Bangladesh: Dhaka, Chittagong, Comilla, Chulna, Rangpur, Mymensingh, Rajshahi and Barisal.

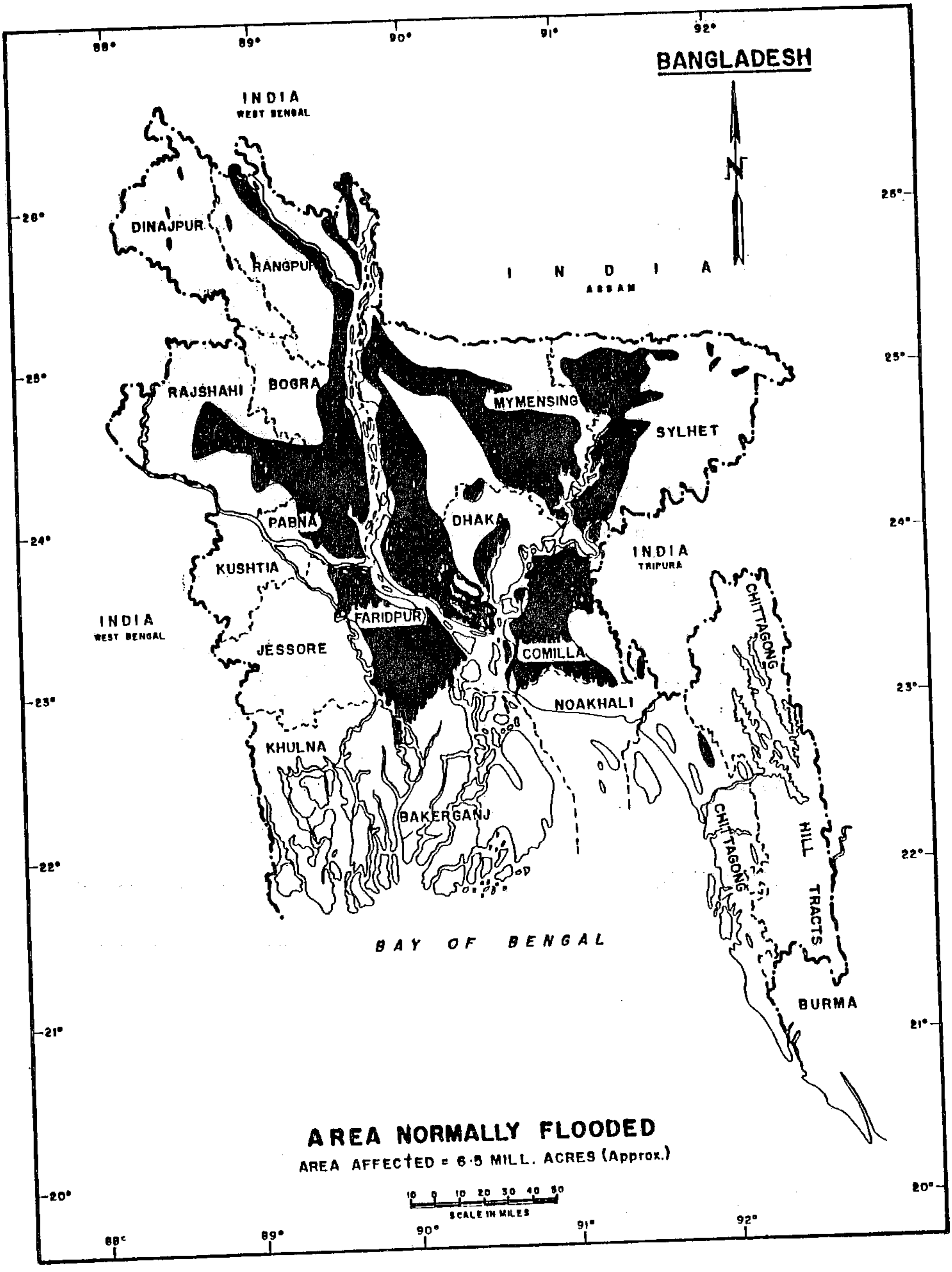


Figure 1. Areas normally flooded

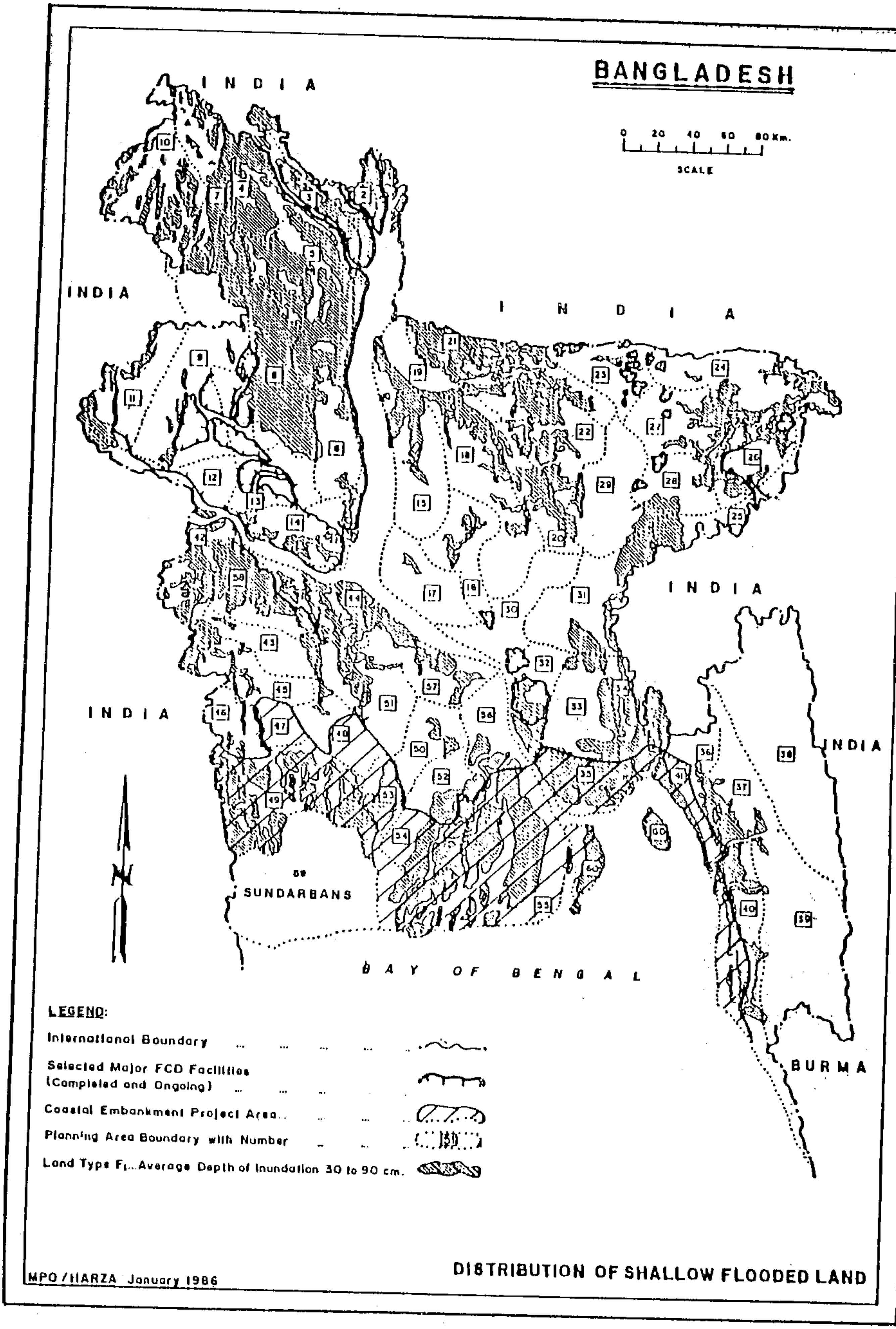


Figure 2. Distribution of shallow, flooded, land

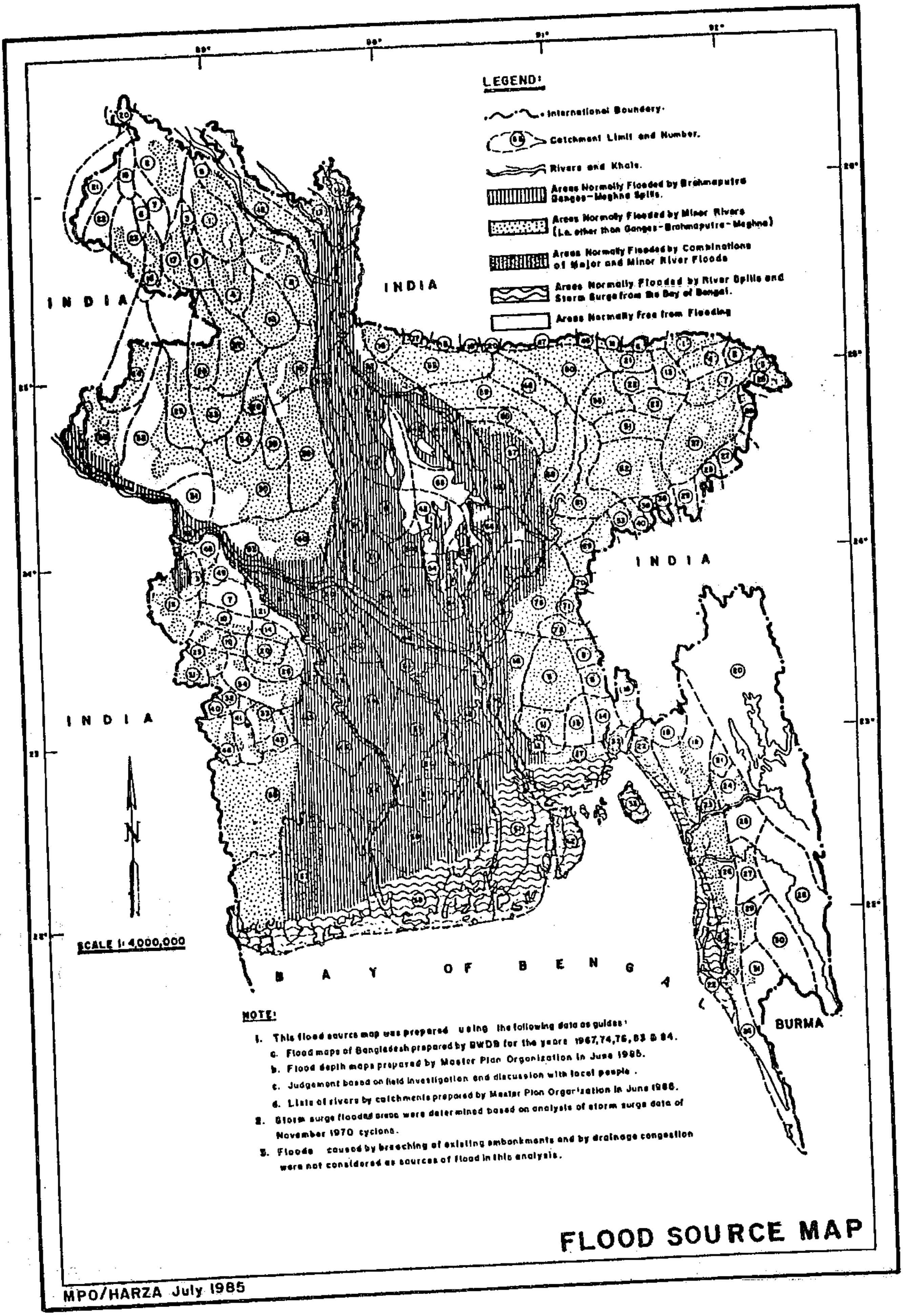


Figure 3. Flood source map

From that study, Tables 1 to 7 have been generated to analyze the effects of the flood on educational buildings both from the point of view of their location in different types of institutions and of the type of construction used.

The conclusions which can be drawn from these tables may be:

1. In all 2584 structures were destroyed and 6736 damaged.

2. Primary schools suffered the most from the damages. Of the total number of destroyed and damaged education structures, primary schools accounted for 86% and 73% of them respectively.

3. Wood and thatch (katcha) structures amount for the bulk of the destroyed buildings (76%).

4. Of the total amount of buildings affected, those with masonry walls and GI sheet roofs (the so-called semi-pucca buildings) have best withstood the flood. Masonry walls with reinforced concrete roofs (pucca buildings) performed second best.

With these conclusions in mind, this study concentrates on primary education and deals with the design of a semi-pucca structure and a pucca structure.

In doing this work, ideas have been based on recent developments in educational buildings in Bangladesh. Since around 1978 the facilities department has been constructing what are known as "semi-pucca" primary school buildings. These structures have brick exterior walls finished with cement plaster. Up until 1982, floors were of rammed earth, the roof trusses of timber, and the brick walls were 10 inches thick. At the time it was felt that this approach provided a sufficiently durable building which, at the same time was quite economical.

With the advent of the World Bank-supported primary education programme, new designs were developed by the Facilities Department following a study which was prepared by Facilities Department staff under the guidance of UNESCO Bangkok. This is published as Alternative building designs for primary schools in Bangladesh, Unesco, Bangkok, 1981. Brick floors with concrete finish are now provided; the roof structure is of steel and the walls, have been designed so as to provide sun and rain protection to the windows and to create storage or display areas inside the classrooms in addition to their normal function of keeping out sun and rain. By reducing wall height, and using thinner walls it has been possible to make enough economies to cover the cost of providing a dry floor. Some 5000 to 6000 buildings with a total of over 15,000 classrooms have been constructed from 1981 to 1987.

Besides the government offer, at least one non-Governmental Organization also participated in this massive construction programme. The Luthern World Service/Rangpur Dinajpur Rehabilitation Service constructed 63 school buildings in 1983-84. These designs are also based on the alternative designs study mentioned above and are particularly noteworthy for the creative use of light steel sections for the building skeleton. This experience is reported in Innovations in management of primary school construction: multi-purpose primary school buildings in Bangladesh; Unesco, Bangkok, 1988.

Having these two solid experiences available (and it is reported in the study on flood damages that "none of the primary school buildings constructed according to the designs of 1978 onward have reported major damage due to flood") the current study has been framed in such a way as to build on previous work. For example the basic size of the school furniture and its geometry have not been changed. New materials and new technologies, however, are proposed.

Table 1. 1987 Flood damages to primary school structures

Type*	Destroyed	Damaged	Total
Pucca	178	910	1088
Semi-pucca	132	1606	1738
Tin shed	236	1150	1386
Katcha	1679	1237	2916
Total	2225	4903	7128

* Pucca = brick/concrete walls, reinforced concrete roof.
Semi-pucca = brick/concrete walls, C.G.I. sheet roof.
Tin shed = wooden structure, C.G.I. cladding on walls and roof.
Katcha = bamboo/wood structure, thatch cladding on walls and roof.

Table 2. 1987 Flood damages to secondary school structures

Type	Destroyed	Damaged	Total
Pucca	22	311	333
Semi-pucca	21	295	316
Tin shed	23	281	304
Katcha	144	332	476
Total	210	1219	1429

Table 3. 1987 Flood damages to Madrasha structures

Type	Destroyed	Damaged	Total
Pucca	4	49	53
Semi-pucca	6	94	100
Tin shed	2	149	151
Katcha	128	234	362
Total	140	526	666

Table 4. 1987 Flood damages to College structures

Type	Destroyed	Damaged	Total
Pucca	2	41	43
Semi-pucca	0	18	18
Tin shed	4	18	22
Katcha	3	11	14
Total	9	88	97

Table 5. 1987 Flood damages to all educational institutions by educational institution level.

Level	Destroyed		Damaged		Total	
Primary	2225	86%	4903	73%	7128	76%
Secondary	210	8%	1219	18%	1429	15%
Madrasha	140	5%	526	8%	666	7%
College	9	-	88	1%	97	1%
Total	2584	99%	6736	100%	9320	99%

Table 6. 1987 Flood damages to all educational institutions by structure type.

Level	Destroyed		Damaged		Total	
Pucca	206	8%	1311	19%	1517	16%
Semi-pucca	159	6%	2013	30%	2172	23%
Tin-shed	265	10%	1598	24%	1863	20%
Katcha	1954	76%	1814	27%	3768	41%
Total	2584	100%	6736	100%	9320	100%

Table 7. 1987 Flood damages: relative performance of structures by type.

	Pucca		Semi-pucca		Tin-shed		Katcha		Total	
Destroyed	206	14%	159	7%	285	15%	1954	52%	2584	28%
Damaged	1311	86%	2013	93%	1598	86%	1814	48%	6736	72%
Total	1517	100%	2172	100%	1883	101%	3768	100%	9320	100%

CHAPTER TWO: SITE DEVELOPMENT AND COMMUNITY PARTICIPATION

Even though the country is predominately agricultural the population density in Bangladesh is high. Consequently land is scarce. Communities are expected to provide one third of an acre for a primary school which may accommodate 300 students on two shifts.

The Bangladesh landscape is characterized by the mounds that have been built up to keep homes above the high water level. Typically these mounds, usually rectilinear in plan, have a number of small structures at the edge thereby creating an interior yard. Ample shade is provided by mango (and other) trees and by great clumps of bamboo.

The school yards of the new primary schools stand in stark contrast. The typical community seems to wait for government assistance and takes no initiative to develop the school site.

This study pre-supposes that the communities will be mobilized to support their schools. In particular their work is counted on to fill and level the land to a height which will keep the school building above the water level of floods which may be expected on a 25 year return. In addition the community would be expected to make special provisions for their livestock and for a community cooking facility that can be used when the school is serving as a refuge.

Three designs are proposed:

Type A. Semi-pucca building having brick walls with G.I. sheet roofing and light steel truss.

Type B. A pucca building having brick walls with brick barrel arch roof as an alternative design to type A.

Type C. A pucca building of two stories with reinforced concrete frame and brick barrel arch.

The communities should strive first to find a site that is above the flood level in which case buildings of type A or B may be used. If the flood level is expected to be no more than two feet above ground level then type A or type B structure may be constructed on top of earth fill not to exceed two feet.

When the school is serving as a refuge there are areas in addition to the classroom block that will also need to be above flood level. These include the toilet block, an area for cooking and a refuge for livestock. The latter two areas would normally have no equipment and would merely be a mound with stabilized slopes.

Figure 4 gives a suggestion as to how a site might be correctly organized for a type A or type B structure. The "box" at the end of this chapter summarizes the contribution that is expected from the community.

In areas where it is not feasible to fill the land to the required level or where the school population is exceptionally high, it will be

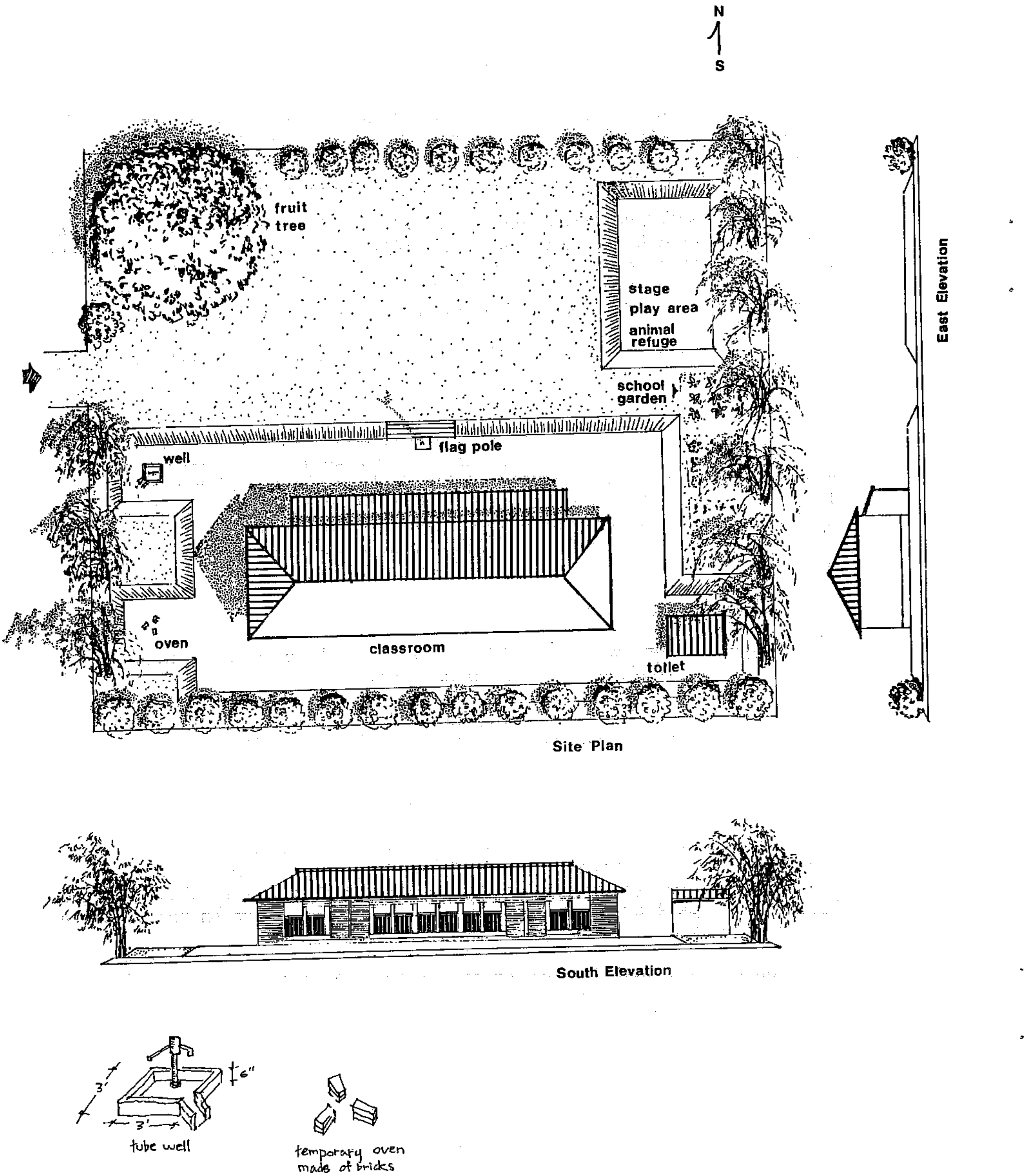


Figure 4. Typical site organization

necessary to utilize the type C two storey structure. Planners should keep in mind, however, that this solution is around six per cent more expensive per student place.

It is strongly recommended that the classroom block be oriented such that the classroom wall openings face North and South. There are, however, a certain number of sites where, if a new building is going to be constructed, this cannot be done. The louvered window design is such that the buildings may be 45% off from this orientation and still ensure reasonable comfort to the inhabitants.

In general it is suggested that low bushes be planted on the north and south borders of the site to stabilize the earth fill and yet not block sun light. By planting taller species, such as bamboo, on the east and west the penetration by the low sun of mornings and evenings may be mitigated. At least one large shade tree such as a mango should also be planted.

Checklist for community contribution to schools/flood refuge centres

1. Donate a minimum of 1/3 acre of high land.

2. Clean and level the site.

3. Fill to above the 25 year flood level (but not to exceed 2 feet) those parts of the site where the following will be located:

   A. Classroom building
   B. Toilet block
   C. Tube well pump
   D. Area for cooking ovens
   E. Area for stage/animal refuge

4. Plant low bushes on slopes of fill at North and South site boundaries.

5. Plant bamboos on slopes of fill at East and West boundaries.

6. Plant at least one large tree (mango or tamarind or other species).

CHAPTER THREE: FURNITURE

School buildings must necessarily be conceived from the inside out so that they will be tailored to the needs of the users. For this reason it is necessary to first review the sizes of furniture and their layout in order to determine the sizes of teaching spaces.

It is felt that the basic design data used in the 1981 alternative buildings designs report remains valid. However, the Bangladesh authorities have decided to construct the desk tops somewhat narrower than was originally recommended. In the following sections those recommendations from the earlier report are repeated with the necessary amendments.

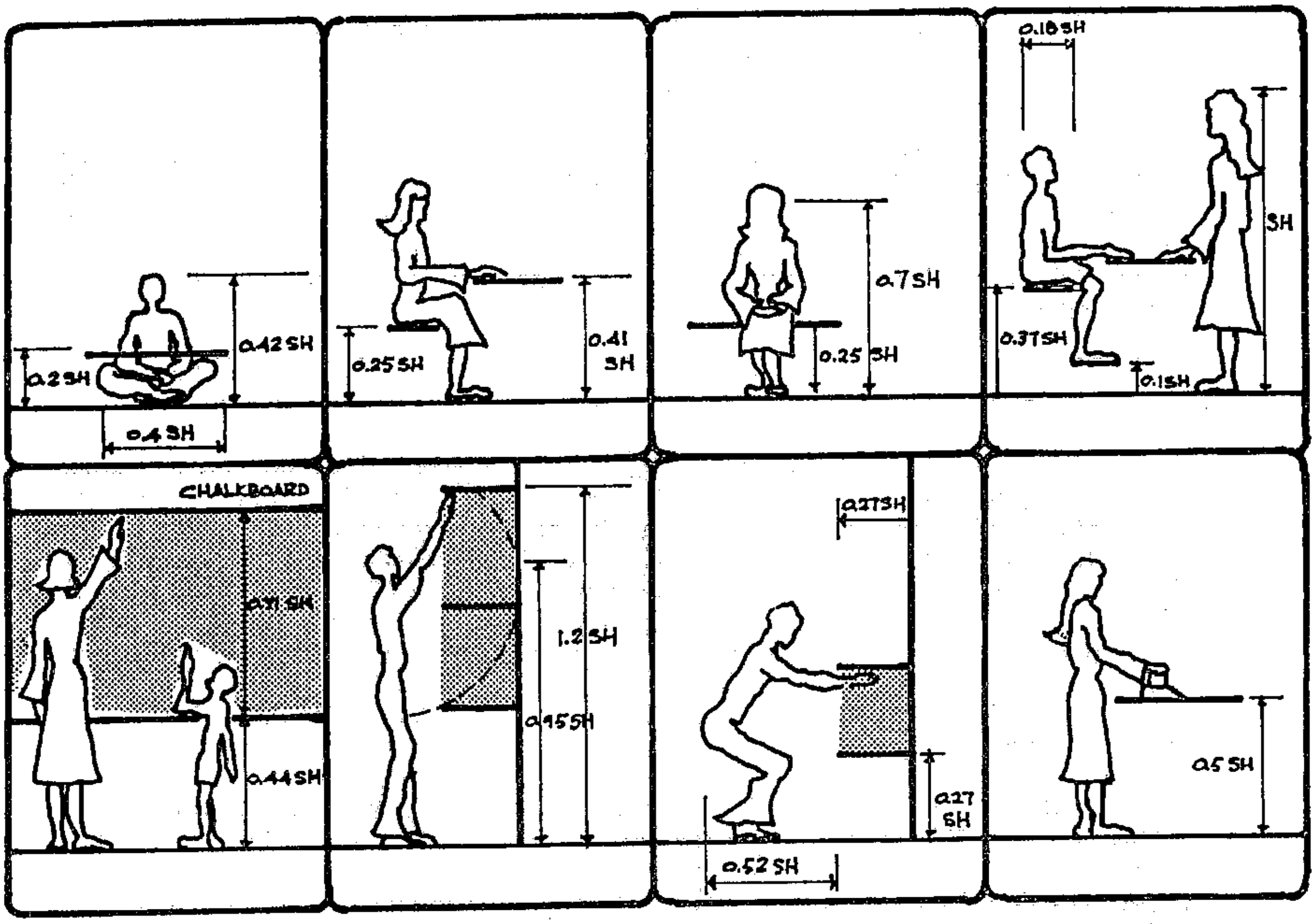
The concept of a desk which may be used by children seated in a "lotus" position has been explored and is suggested for some schools.

The idea of manufacturing large furniture units which combine work and seating surfaces is strongly discouraged by Unesco. In the case of flood affected schools it will be necessary to remove the furniture from the classrooms during emergencies. For this reason the portability of the furniture is essential. There are also two strong pedagogical arguments against these large units. They stifle educational development by making it impossible to rearrange the furniture for peer group teaching. Furthermore whenever one child moves position he or she may cause disturbances to the children sitting or writing at the same piece of furniture.

What has changed over the intervening seven years is materials and technology. It is no longer a sound idea to use timber furniture for primary schools in Bangladesh. Costs have gone up and quality of materials declined. Furthermore in the flood situation it is essential to reduce - even eliminate - timber in the schools. Thus two alternative new designs have been developed which would use standard steel sections for frames and die stamped steel sheets for the tops.

Technical drawings for the suggested new furniture and photographs of prototypes are given in Figures 9 and 10. A suggestion for the lotus position desk is given in Figure 11.

While these will certainly not be the definitive design selected, they may introduce some directions to be pursued. The ends and horizontal braces may be prefabricated separately and zinc coated in the factory. These may be transported knocked down and assembled on site preferably using rivets; alternatively using bolts and hammering the end after firmly tightening the nuts.



Proportion of Standing Height	Design dimensions in inches		
	6-7 years	10 years	Adult
0.15	7	9	-
0.18	8	9	-
0.20	9	10	-
0.25	11.5	13	16
0.37	17	19	-
0.40	18	21	-
0.41	18.5	21	26
0.42	19	22	-
0.44	-	-	28
0.50	23	26	-
0.70	32	36	-
0.71	-	-	45.5
0.95	-	-	61
1.00	45.5	52	-
1.20	-	-	77

Figure 5. Design proportions and dimensions based on body sizes

Because of the split shift system, both large and small children will use the same furniture. For this reason it is suggested that there be only one size of furniture.

In the case of the tables, this can be accommodated by providing a foot rest for the smaller children. For the low bench, a foot rest can also be provided for small children which can double as a book shelf for the older boys and girls. The low bench should be so designed that it can be placed at least partially under the table. This will allow for ease in rearranging the furniture and cleaning the classrooms.

Considering that each table will be occupied by 3 pupils if all are attending class, but that they may also frequently be used by only two students due to variable class size and absent students, tables should be designed so that they can efficiently accommodate either two or three pupils. This is illustrated in Figure 6.

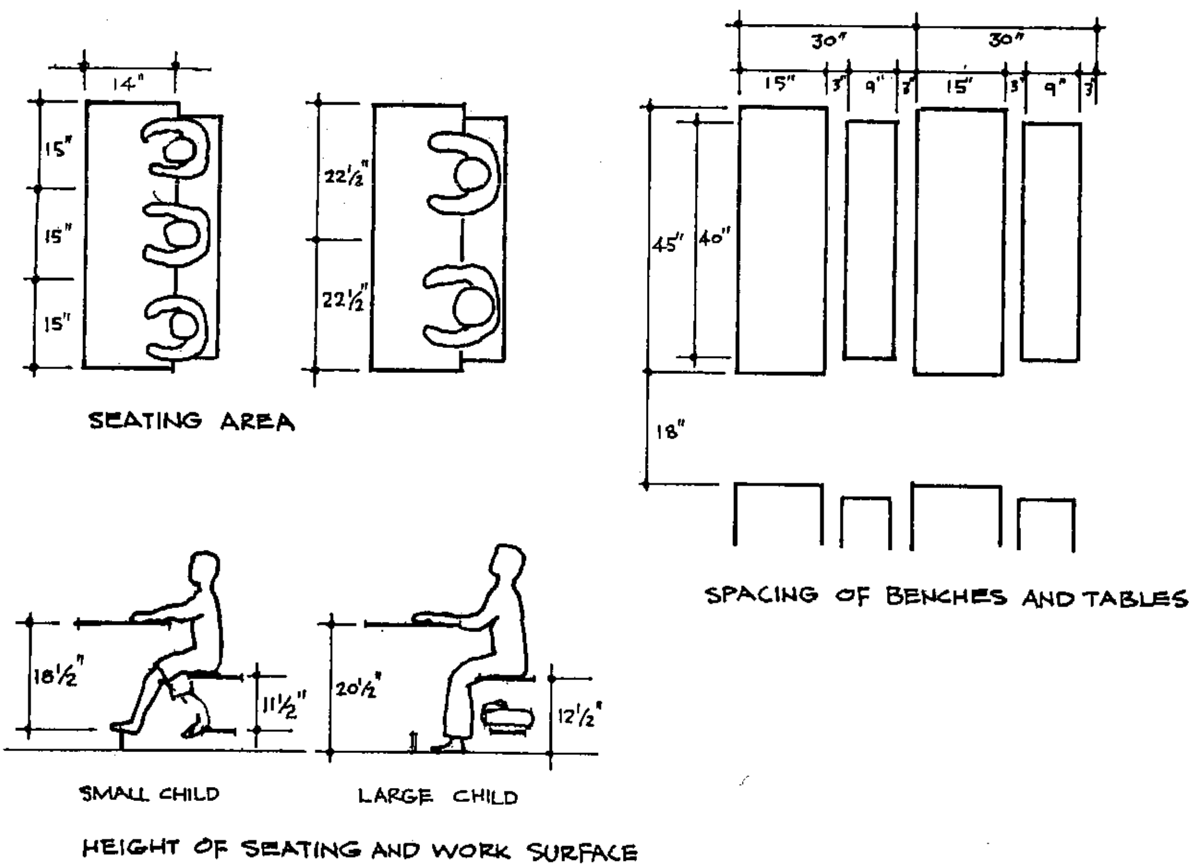


Figure 6. Basis for furniture design

Classroom layout

Following from this dimension classroom width has been determined at 19' 6" offering the possibility of accommodating 4 tables across the width of the classroom or their rearrangement for small group work as shown in Figure 7.

The area per place for various sized classes is shown in Figure 8.

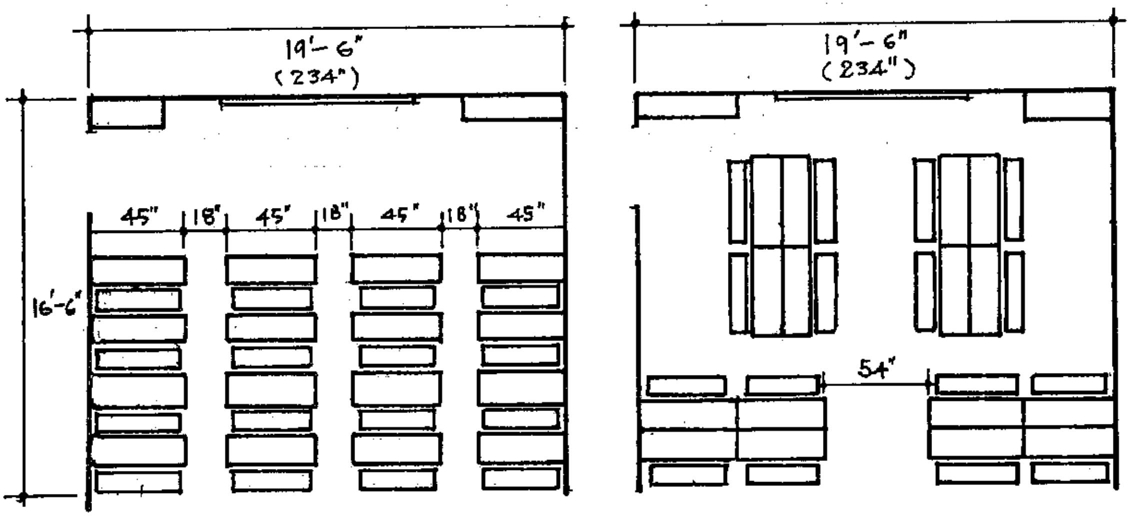
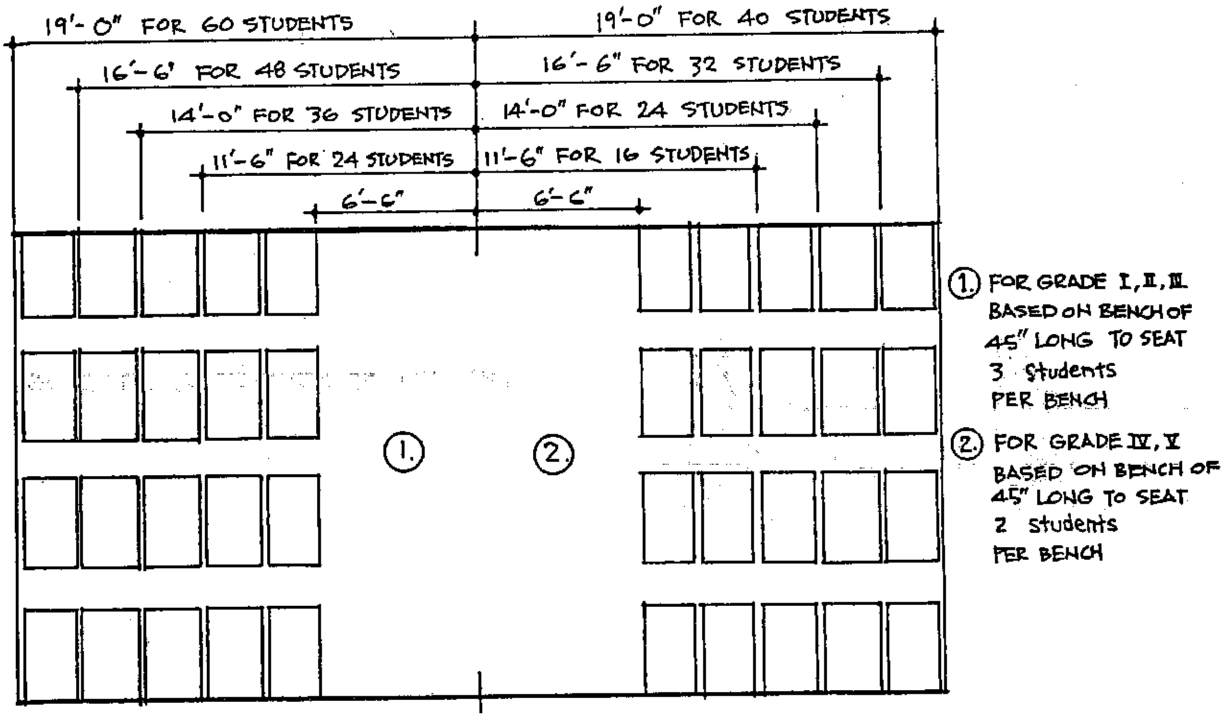
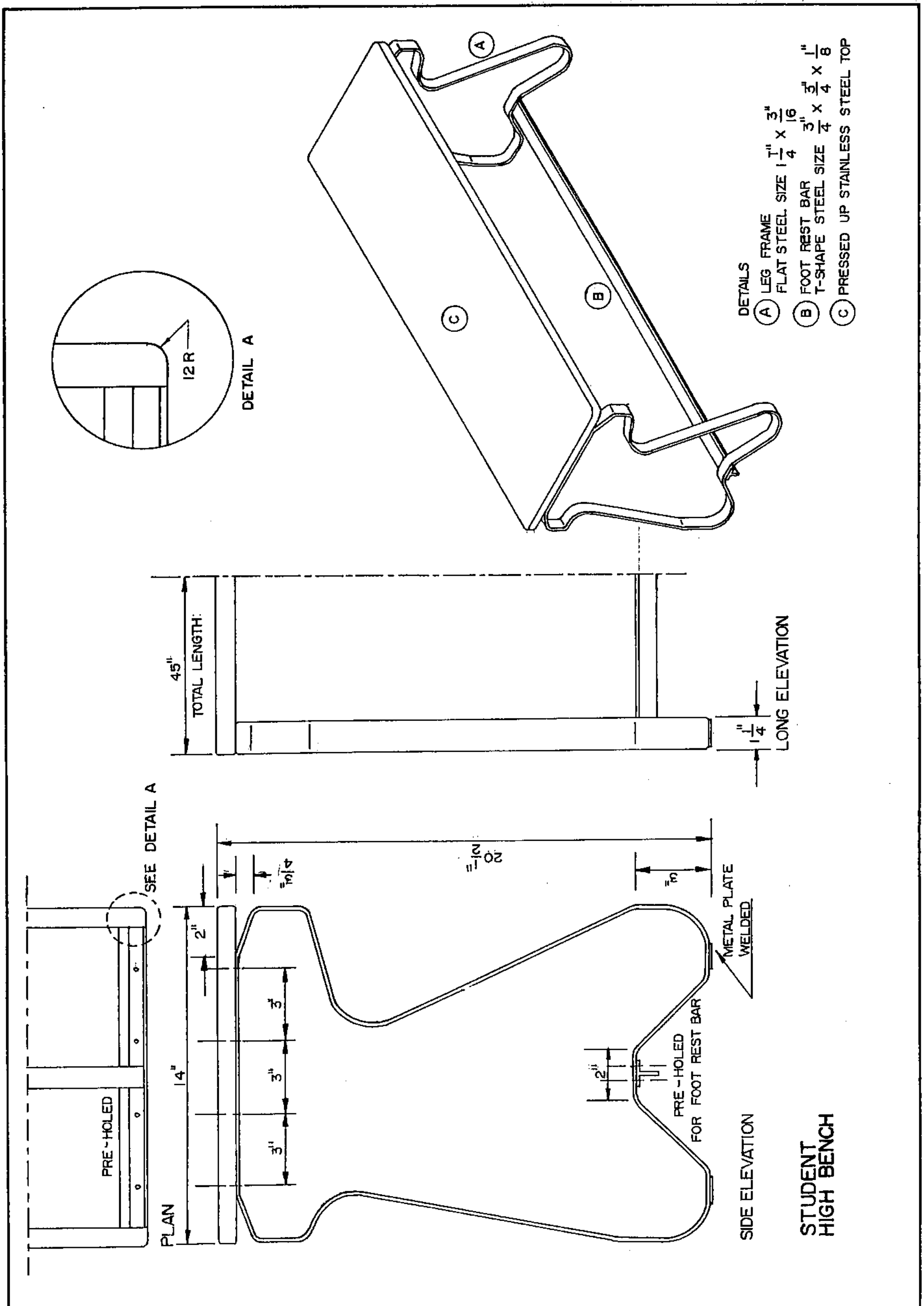


Figure 7. Classroom furniture arrangements



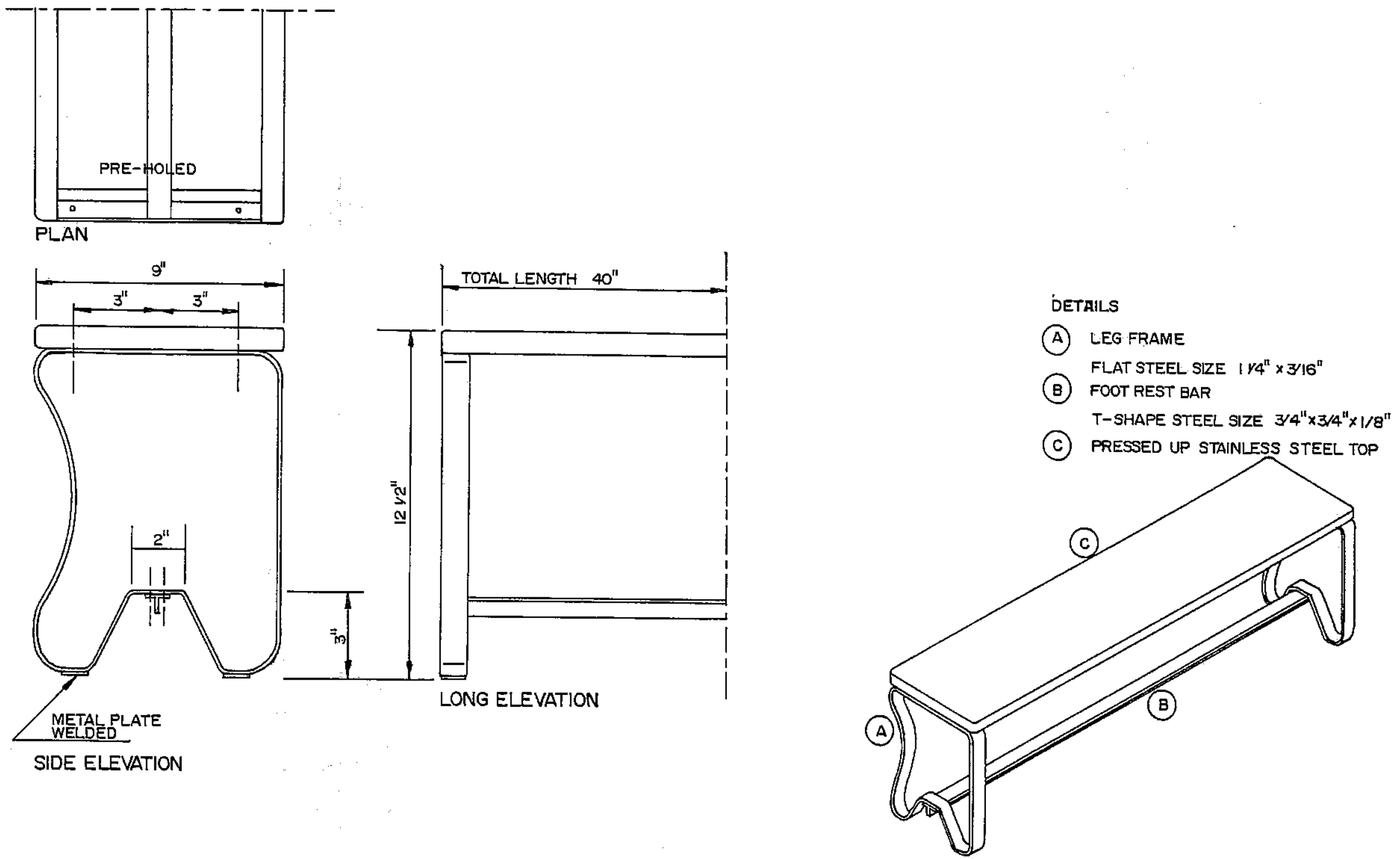
ROOM	ROOM SIZE	STUDENT PER CLASS	AREA PER STUDENT
A	19'-0" x 19'-6" = 370 SFT	60 / 40	6.18 SFT / 9.26 SFT
B	16'-6' x 19'-6' = 322 SFT	48 / 32	6.68 SFT / 10.03 SFT
C	14'-0" x 19'-6" = 273 SFT	36 / 24	7.58 SFT / 11.37 SFT
D	11'-6' x 19'-6' = 224 SFT	24 / 16	9.33 SFT / 14.01 SFT

Figure 8. Area per place for various sized classes

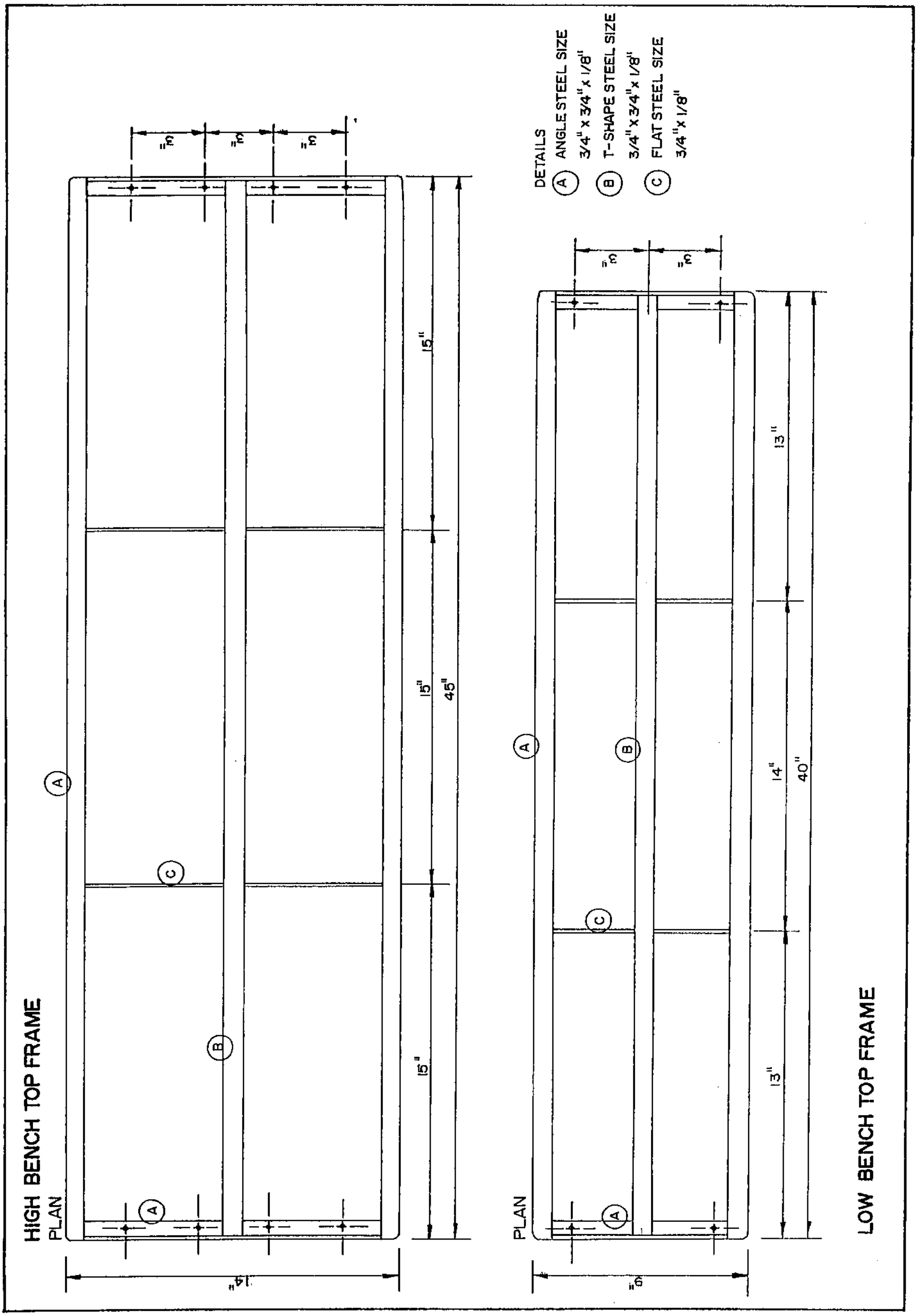


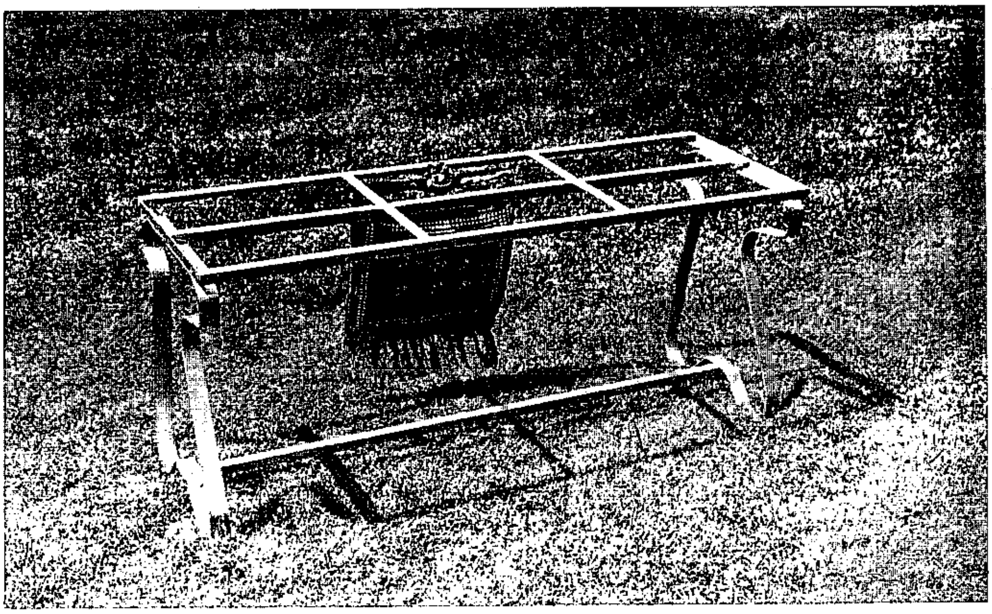
a) technical drawings

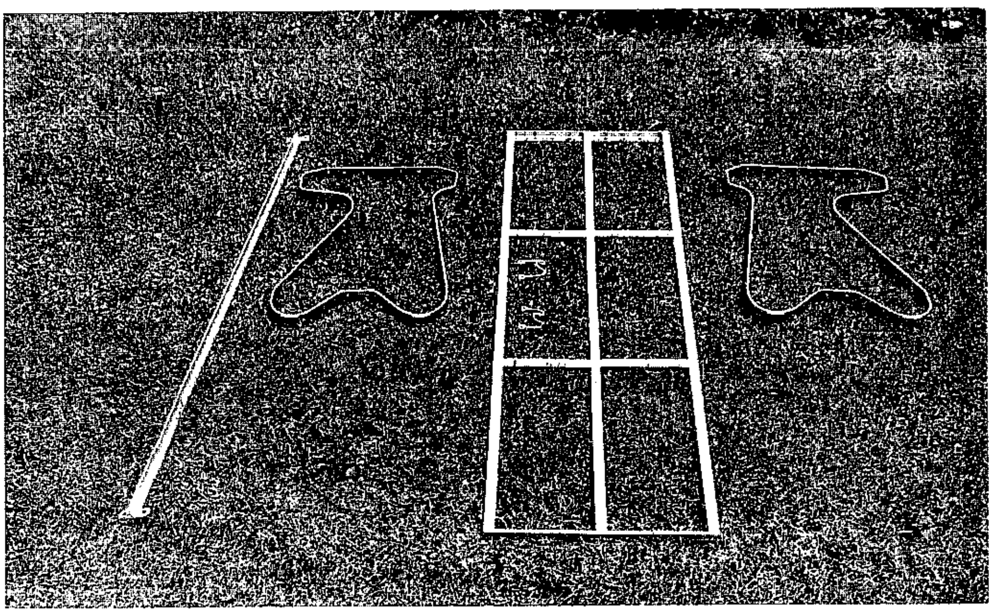
Figure 9. Flat steel frame furniture



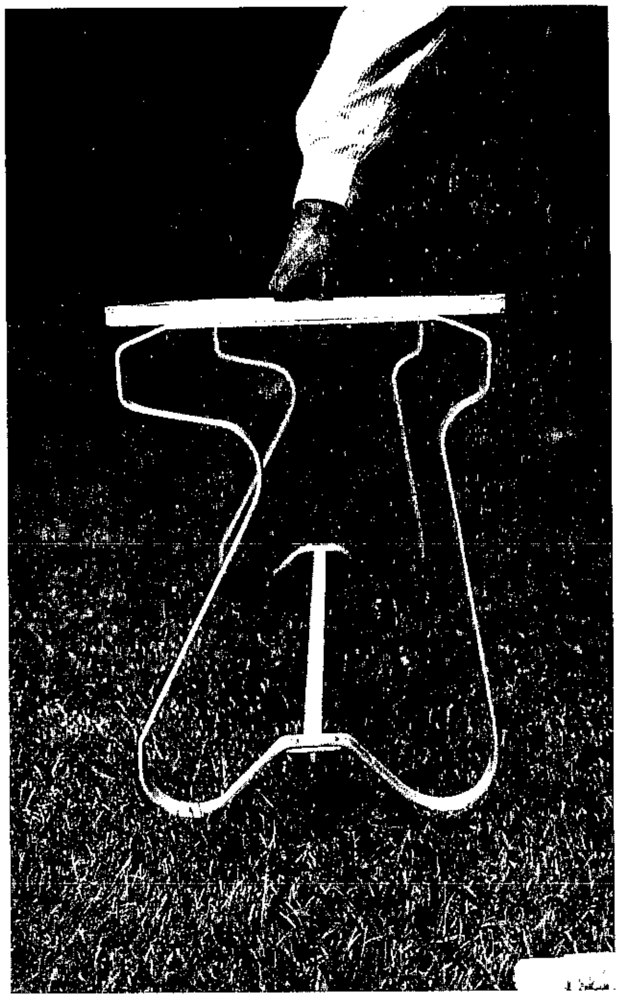
STUDENT LOW BENCH

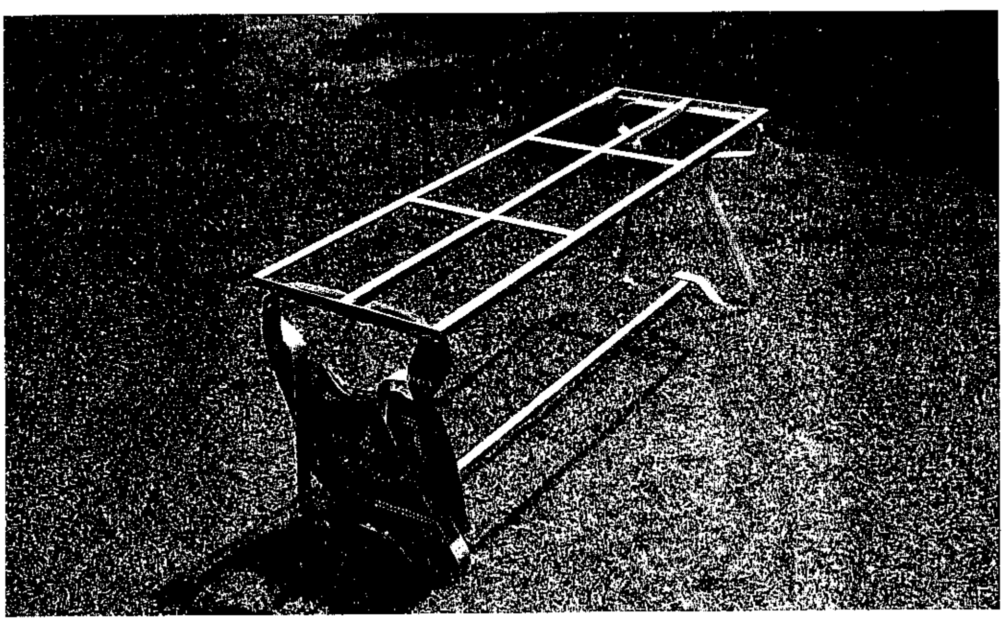

HIGH BENCH TOP FRAME
PLAN
LOW BENCH TOP FRAME
PLAN
DETAILS
A ANGLE STEEL SIZE 3/4" x 3/4" x 1/8"
B T-SHAPE STEEL SIZE 3/4" x 3/4" x 1/8"
C FLAT STEEL SIZE 3/4" x 1/8"
15"
15"
15"
45"
14"
3"
13"
14"
13"
40"
9"

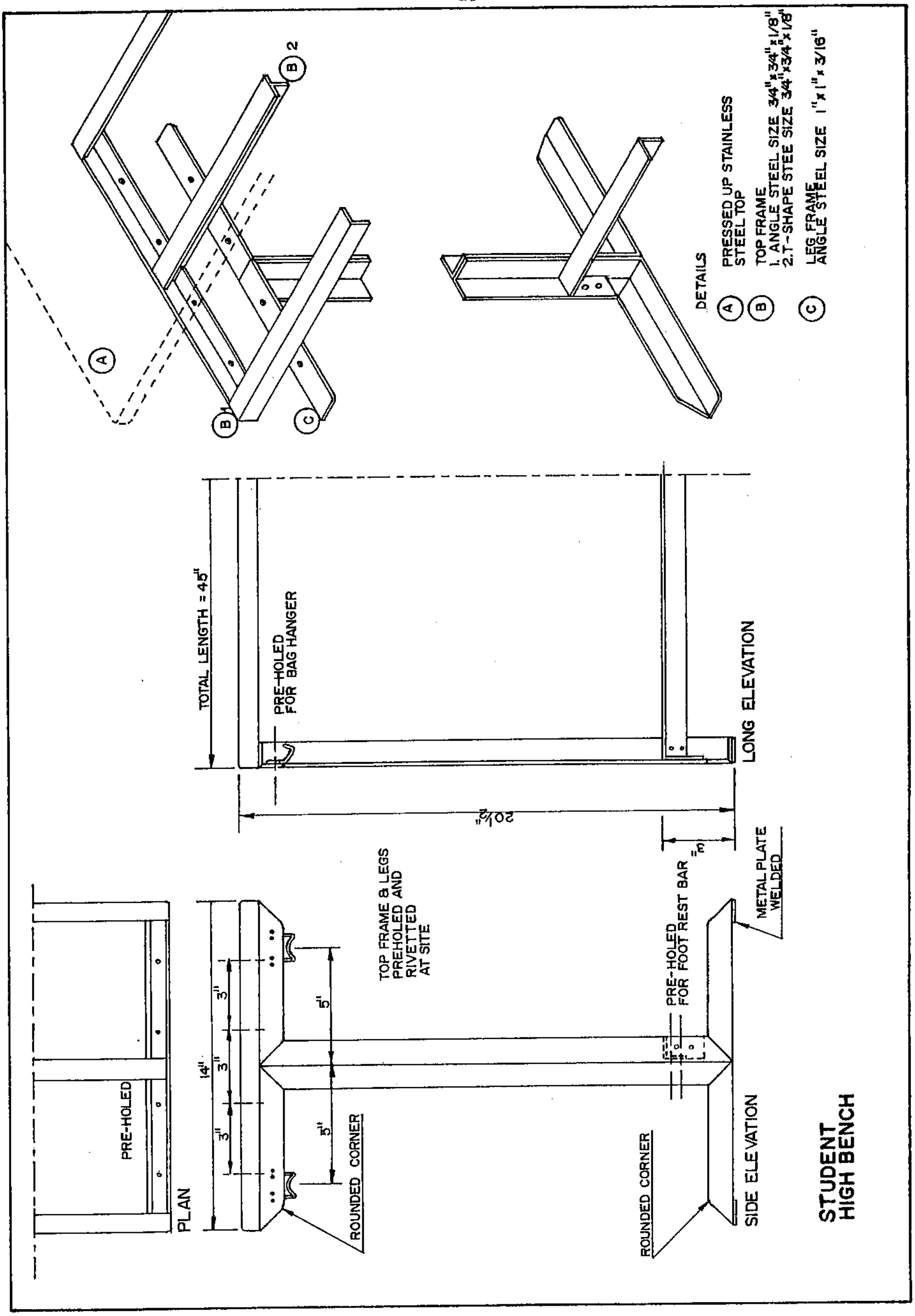




b) photograph of prototype

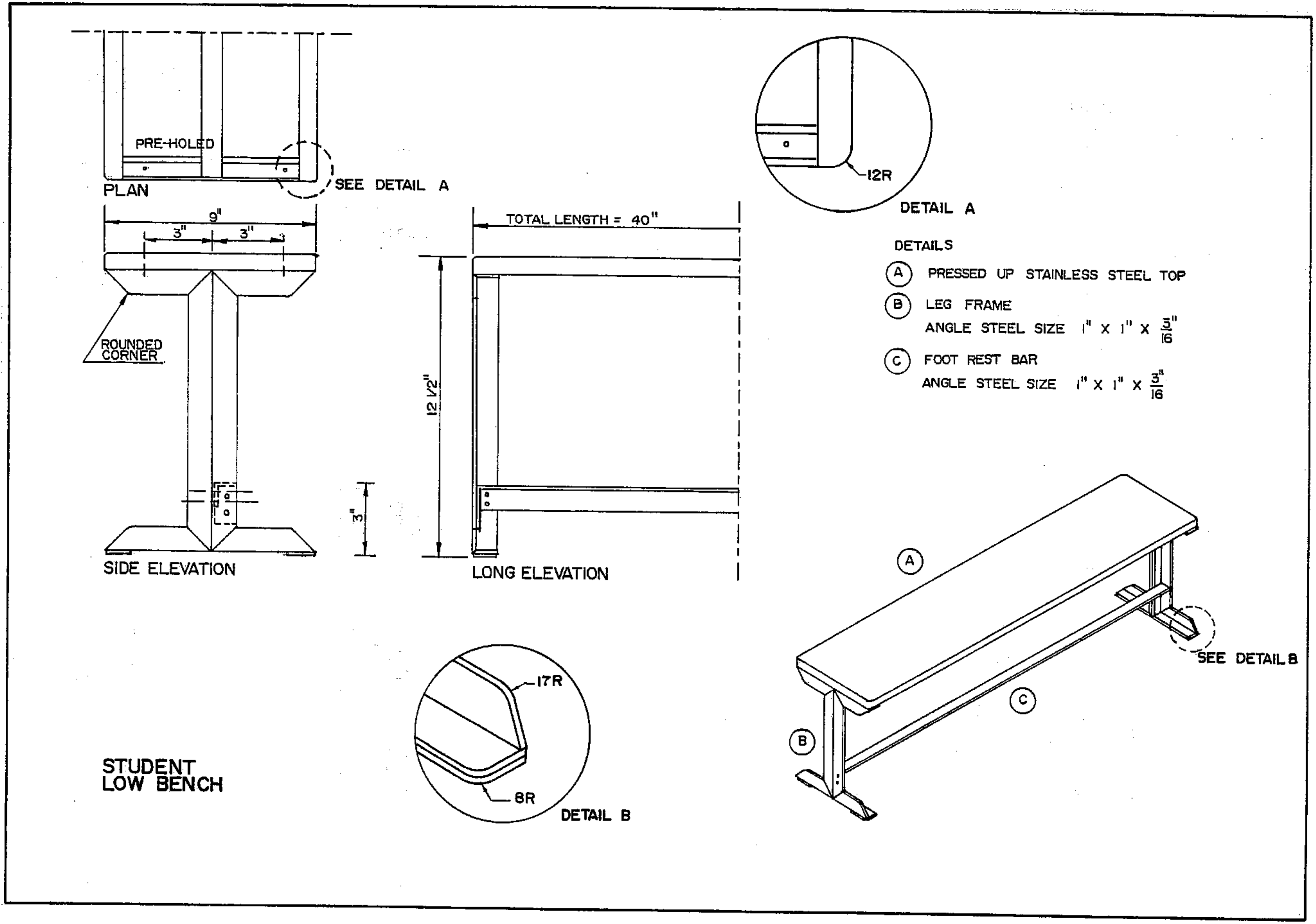




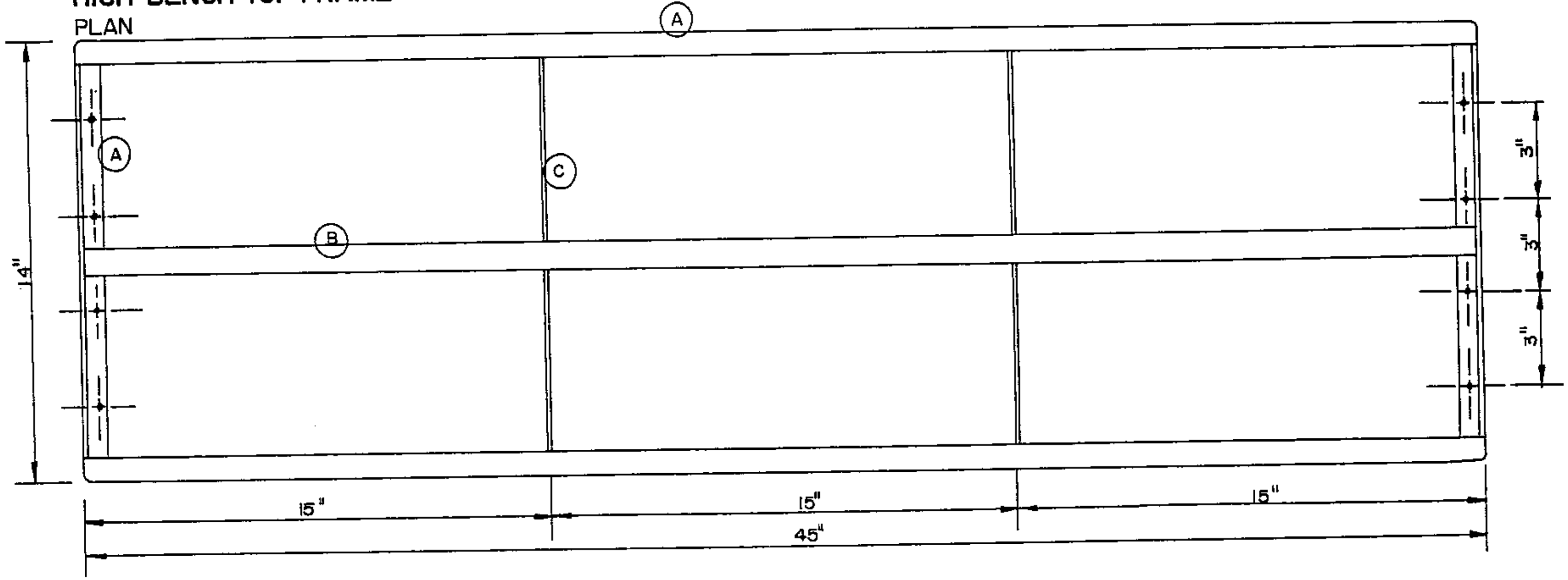


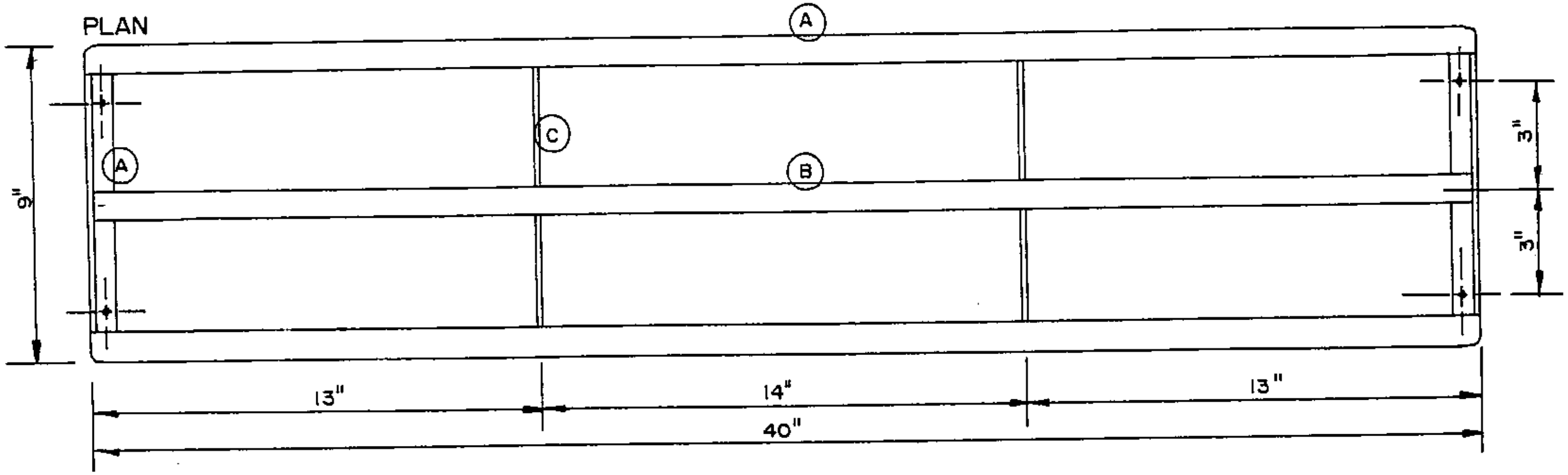
a) technical drawings

Figure 10. Angle iron steel frame furniture


PRE-HOLED
PLAN
SEE DETAIL A
9"
3"
3"
ROUNDED CORNER
SIDE ELEVATION
3"
TOTAL LENGTH = 40"
12 1/2"
LONG ELEVATION
12R
DETAIL A
DETAILS
A PRESSED UP STAINLESS STEEL TOP
B LEG FRAME
ANGLE STEEL SIZE 1" X 1" X 3/16"
C FOOT REST BAR
ANGLE STEEL SIZE 1" X 1" X 3/16"
A
B
C
SEE DETAIL B
17R
8R
DETAIL B
STUDENT
LOW BENCH

HIGH BENCH TOP FRAME





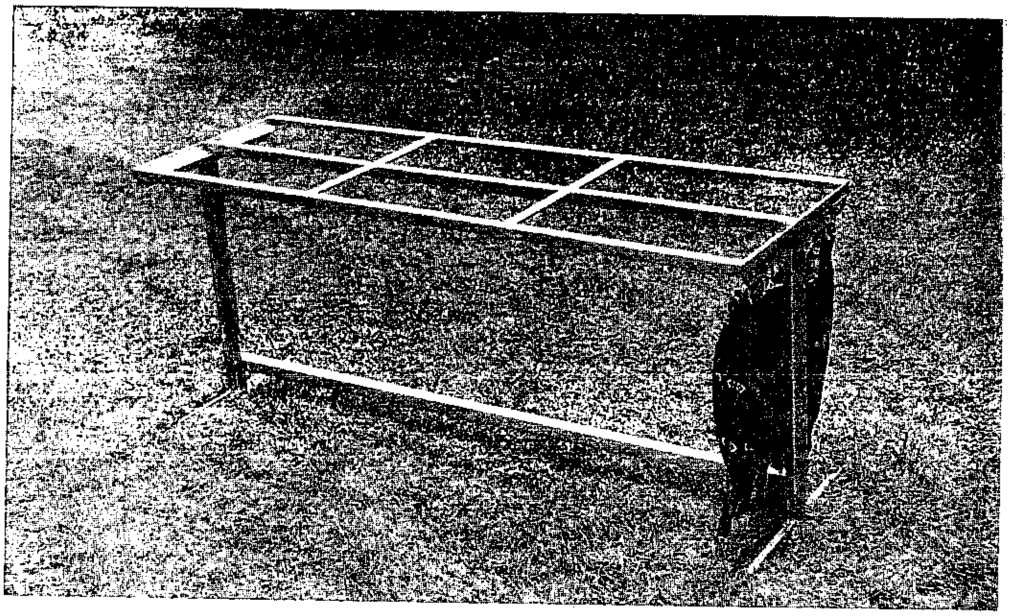
DETAILS

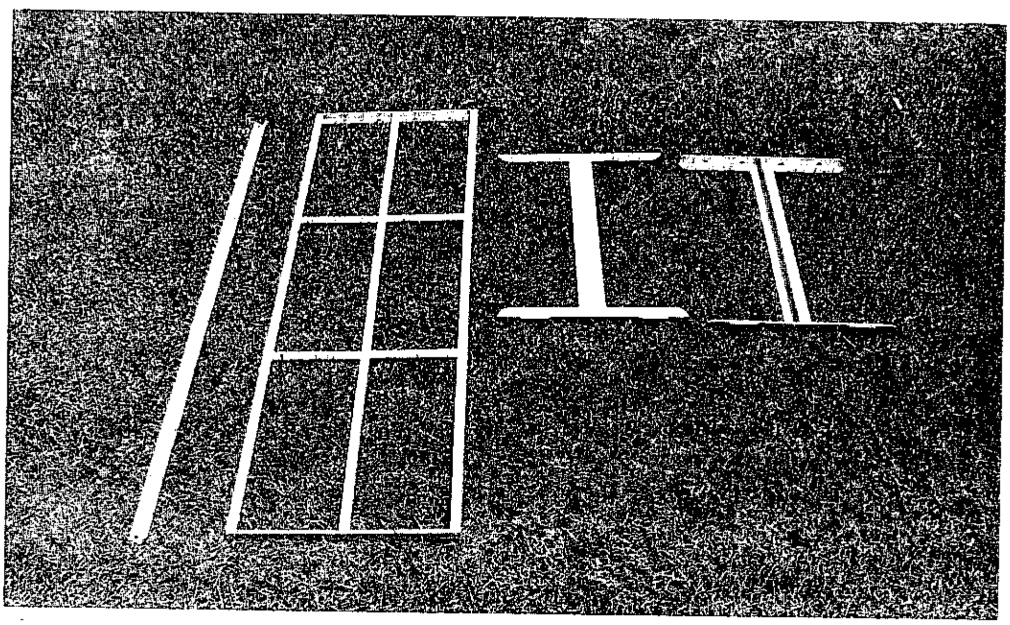
(A) ANGLE STEEL SIZE 3/4" x 3/4" x 1/8"

(B) T-SHAPE STEEL SIZE 3/4" x 3/4" x 1/8"

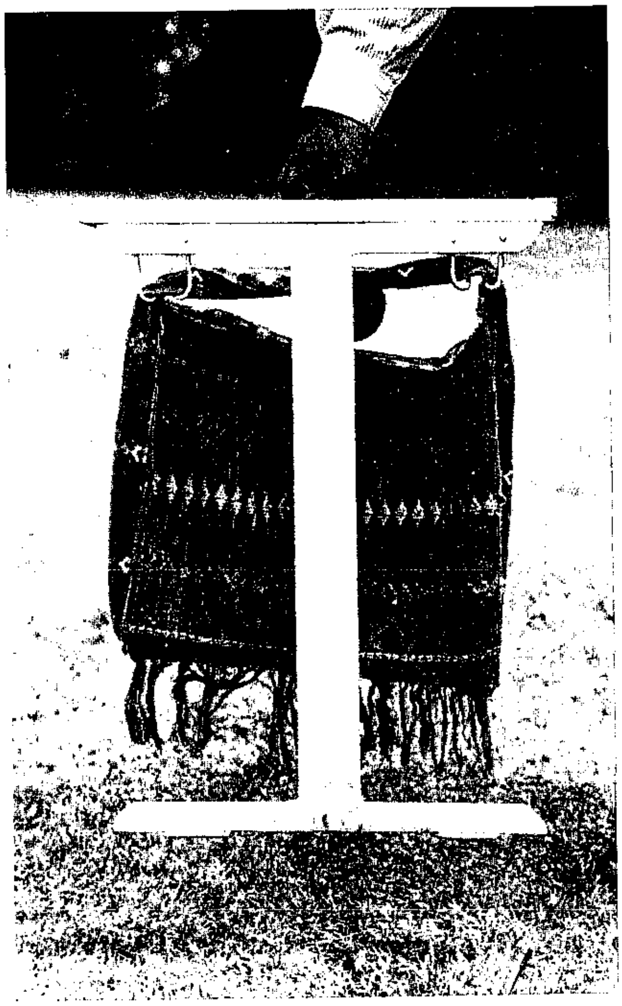
(C) FLAT STEEL SIZE 3/4" x 1/8"

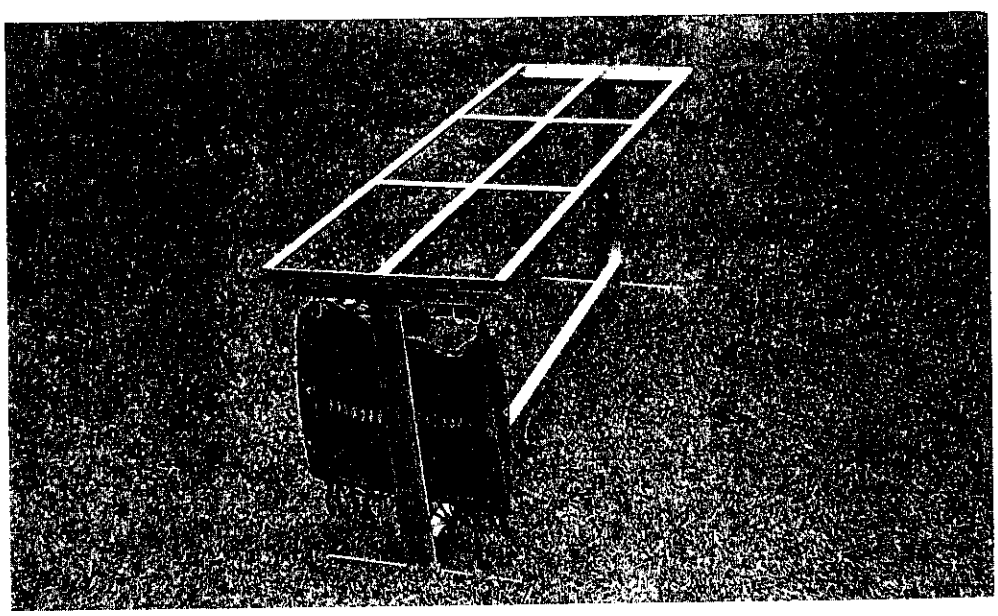
LOW BENCH TOP FRAME





b) photograph of prototype





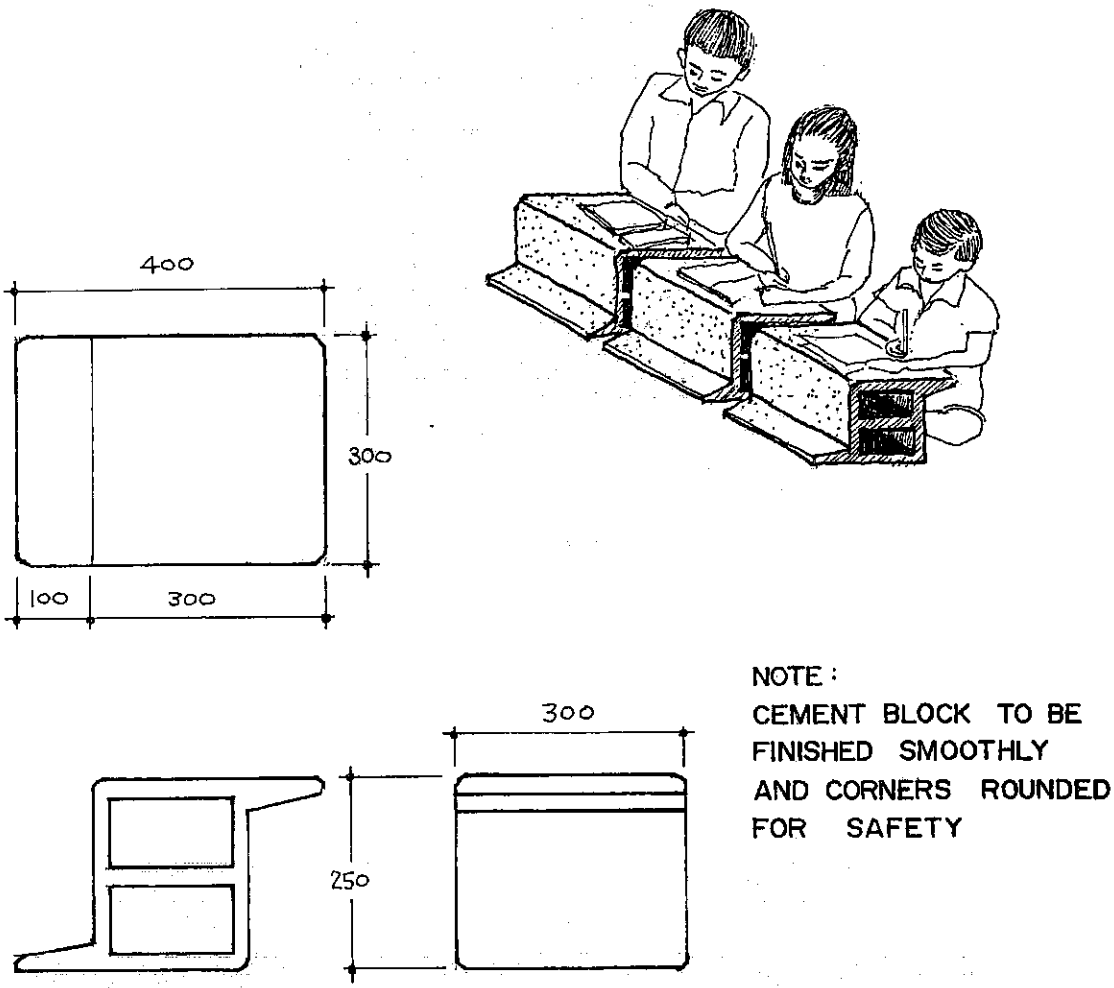


Figure 11. Lotus position desk

CHAPTER FOUR: BUILDINGS FOR HIGH GROUND

The Ministry of Education intends to build these new school cum shelter structures on high ground whenever possible. It may be hoped, therefore, that aside from the correct application of traditional mound building techniques already covered in Chapter Three, the schools will appear to be quite similar to their predecessors.

The floor plan has been amended to enlarge one of the three classrooms and to provide a teacher's room which is in conformity to government standards of 60 sft per teacher. As the currently provided space of 8' 8" x 19' 6" is a very inconveniently proportioned space, the new teacher's area is 13' 0" x 19' 6". About 90 sft of this area of 253 sft is set aside for a school library or it may be used for storage. In time of flooding this space can hold all the classroom furniture if it is neatly placed in two layers and the benches placed under the desks. By locking the door all school records and equipment will be secure. The capacity of this school is calculated at 336 students, assuming three children per desk and a double shift operation.

The classroom areas are of variable sizes. Two rooms accommodate 16 double desks and one room accommodate 24. A flexible partition is used between two rooms to permit the creation of a large room when required. By placing the teacher's room between two classrooms acoustical isolation between classrooms is improved.

The verandah has been adopted by the government even though it substantially reduces the light level in the classrooms. By stopping it short on either end of the building, the two end classrooms will benefit from having at least one window unobstructed by the verandah.

The windows are vertical steel louvers (see design in Annex 2). This avoids the need of placing iron security bars on the windows. It also allows the windows to be adjusted against sun coming from the east or west, should the building be poorly oriented.

The major change is in the newly designed roofs.

The shape of the roof on the type A design follows the traditional "four-challa" design of rural Bangladesh buildings. It will provide rain protection to all four walls of the building thus avoiding the problem of damp walls which has troubled previous designs. All timber has been removed from the structure to remove the temptation to use building components for firewood.

The roof structure is of two light weight prefabricated trusses which, together use less steel than did the earlier design. These trusses are to be connected with a special crown trap. To achieve the connection with the hip roof at the ridge, the crown trap has additional connectors to receive the hip ridges.

Figures 12 and 13 give the plan of the building for school use and refuge use. The number of refugees who could comfortably be accommodated is 36. Figure 14 shows the building in elevations while Figure 15 shows the section with the pitched, bamboo mat ceiling. The concept of the roof framing plan is given in Figure 16. A full set of details are given in Annex 2.

Type B design uses the same floor plan as type A, but has a different roof structure. Here, it is proposed that a brick barrel vault be used. This can utilize locally available materials at about the same cost as the steel roof. Figure 17 shows the buildings in elevation. Details of the roof structure can be found in Annex 3.

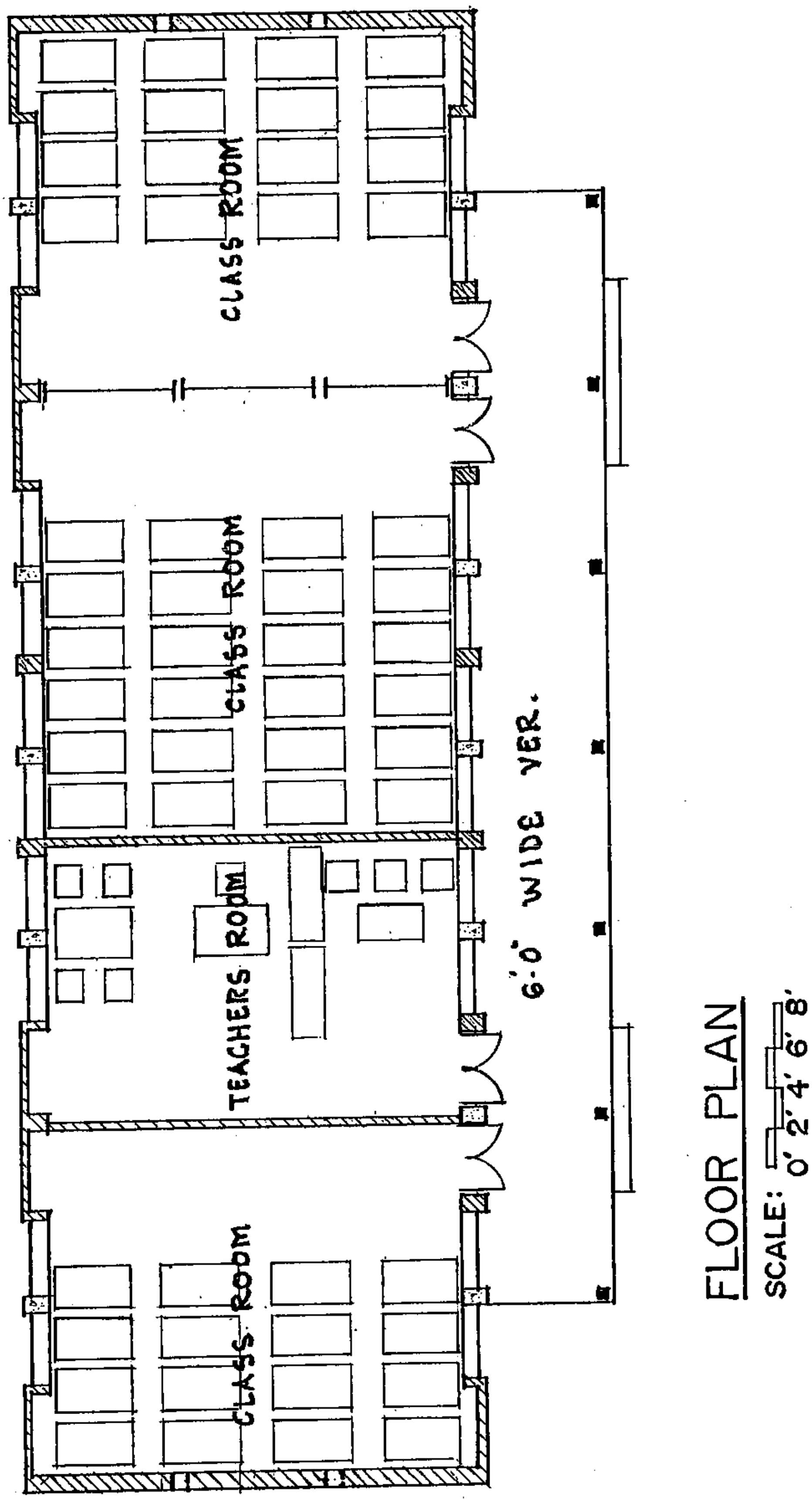


Figure 12. Type A. Building for high ground: Arranged for school use

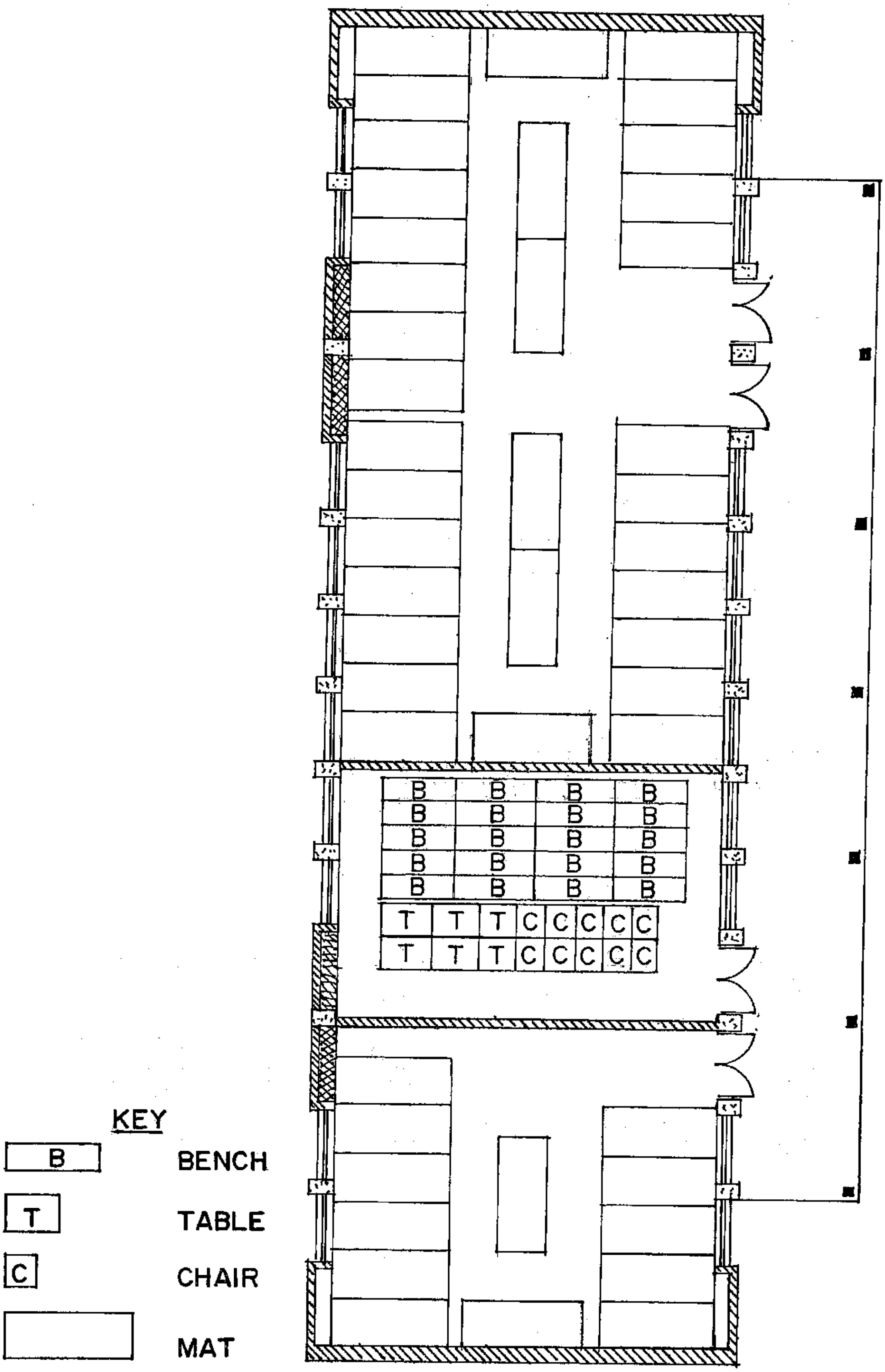


Figure 13. Type A. Building for high ground: Arranged for refuge use

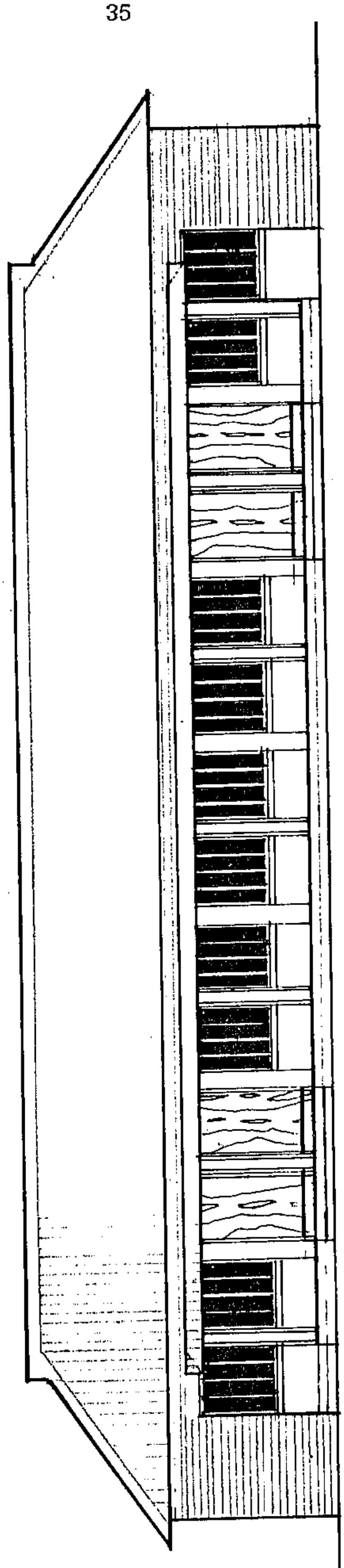


Figure 14. Type A. Building for high ground: Elevations

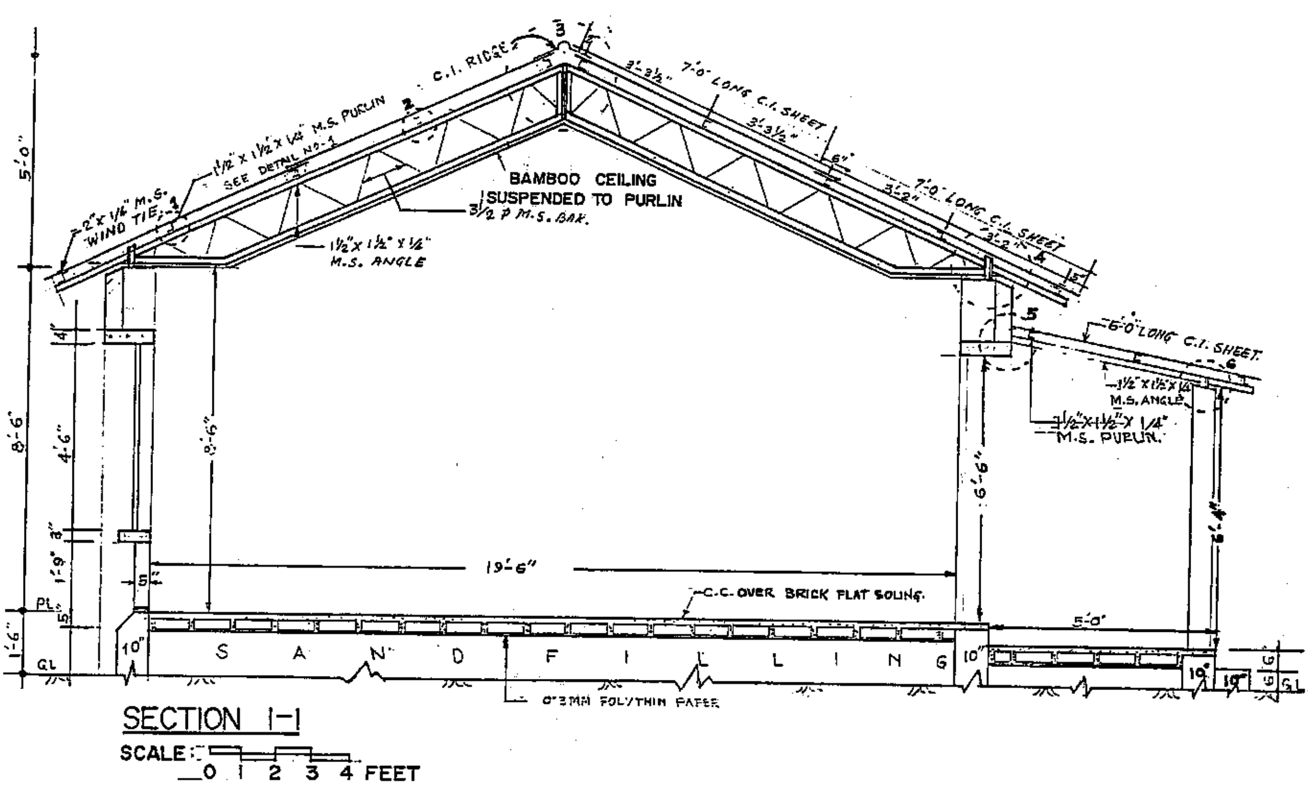


Figure 15. Type A. Building for high ground: Sections

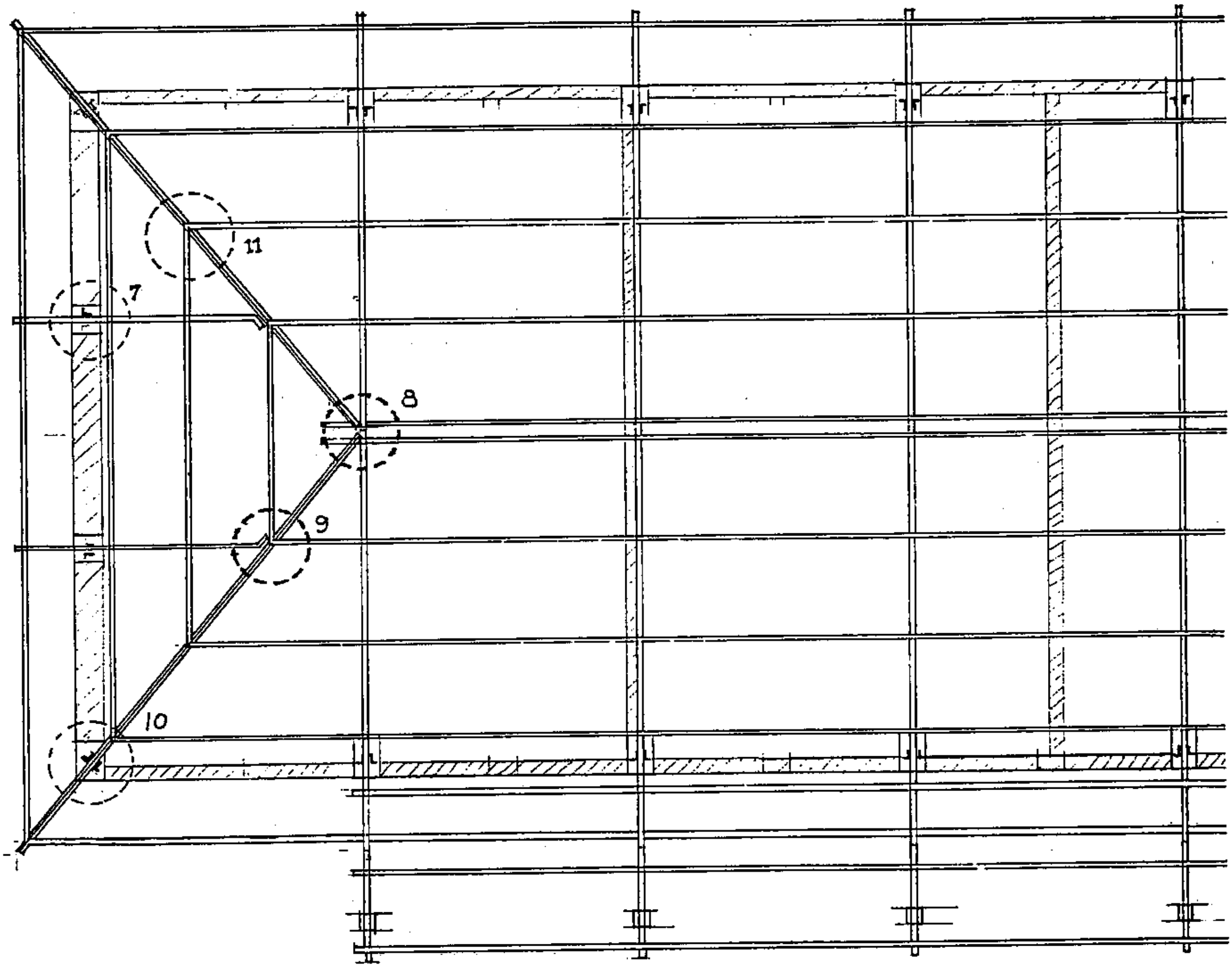
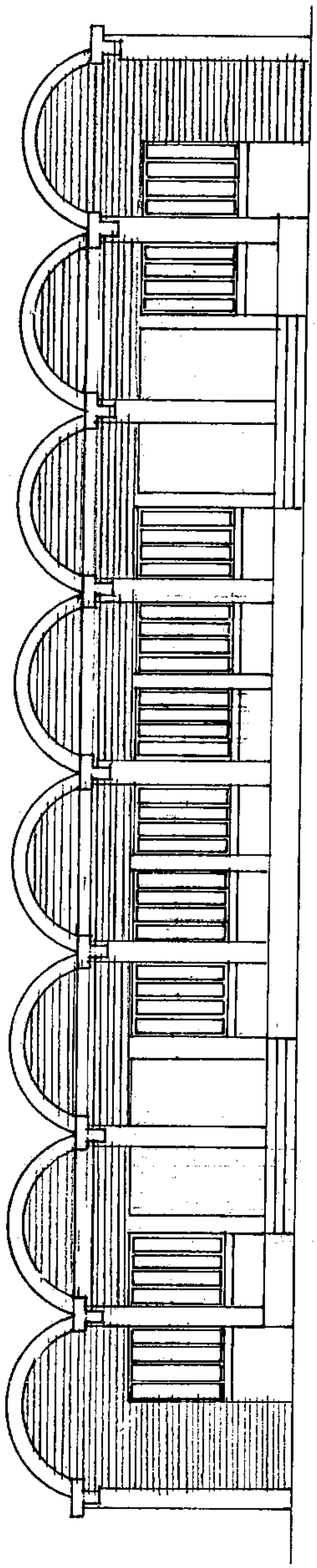


Figure 16. Type A. Building for high ground: Roof framing plan



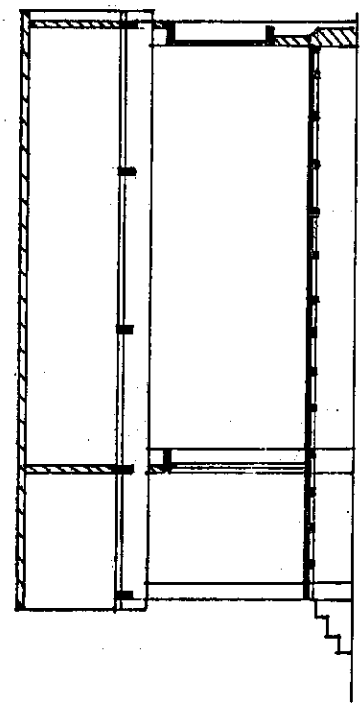


Figure 17. Type B. Building for high ground: Elevations and sections

CHAPTER FIVE: BUILDINGS FOR LOW GROUND

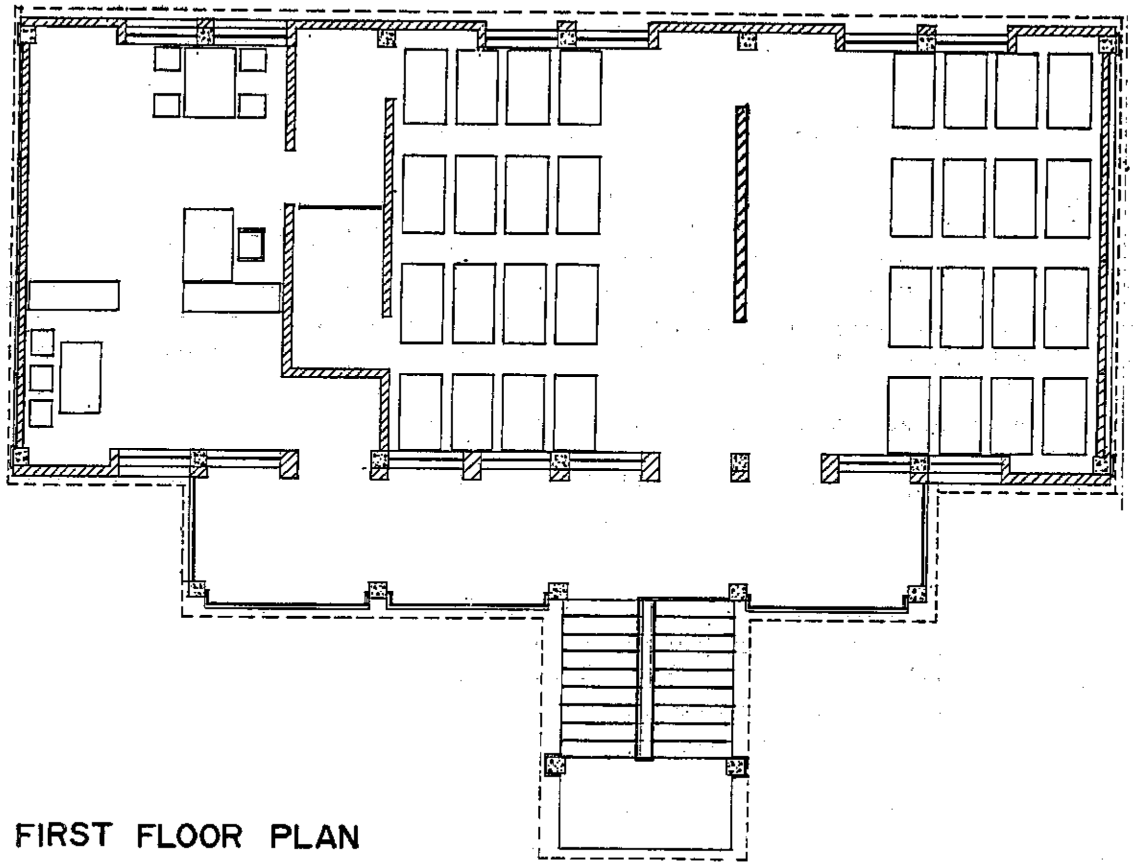
When sites on high ground cannot be found, it is necessary to construct double storey structures. The type C building provides for an open hall at ground level and two classrooms and a teachers' room upstairs. The total pupil capacity is 500. This is the smallest economical size having two classrooms upstairs and three at ground level whereas building types A and B have three classrooms at ground level only. Only the upper storey would be available as a refuge as it is assumed the ground level will be under water in time of flood.

This design pre-supposes that students attending class on the ground level will sit in the lotus position at low desks which would be made of reinforced concrete.

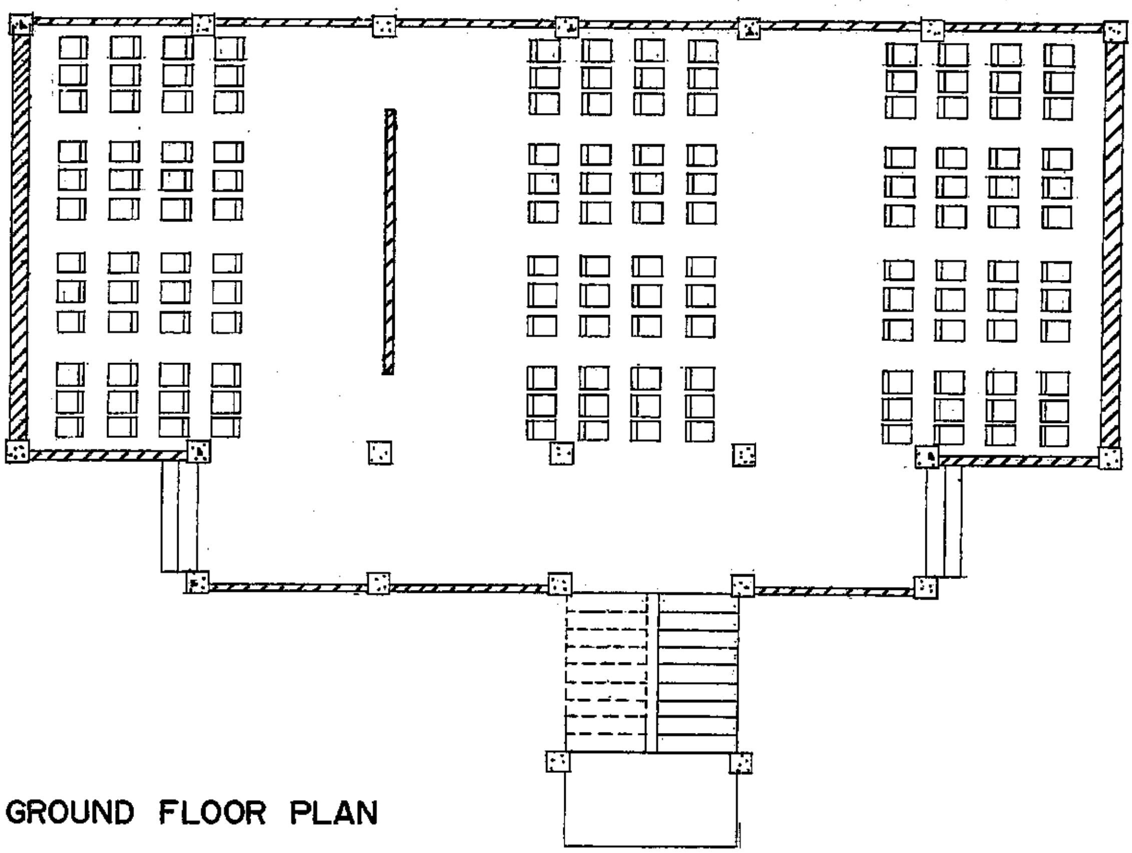
As the school latrine may be inaccessible in time of flood an emergency arrangement needs to be provided. It is suggested that the materials normally kept in the school store rooms be moved to the teachers' room cum library and that the school store be partitioned to create two temporary latrines.

The roof structure is of the brick barrel vault type which can be constructed of locally available brick.

Figures 18 and 19 show the plans of type Type C buildings arranged, respectively, for school and refuge use. The number of beds for refugees which can comfortably be accommodated is 26. Figures 20 and 21 give the elevations and section. A full set of drawings is given in Annex 4.



FIRST FLOOR PLAN



GROUND FLOOR PLAN

Figure 18. Type C. building for low ground: Arranged for school use

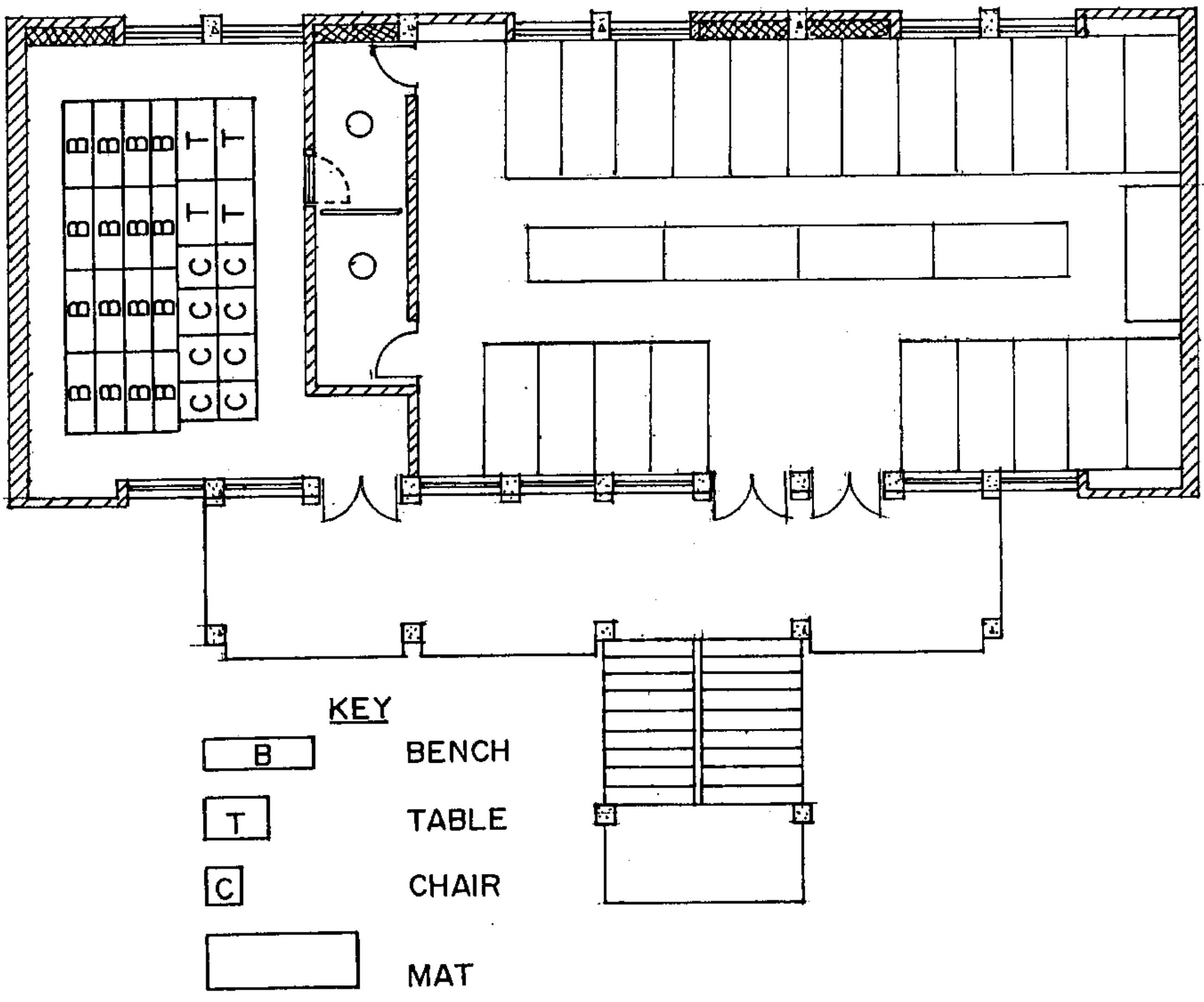
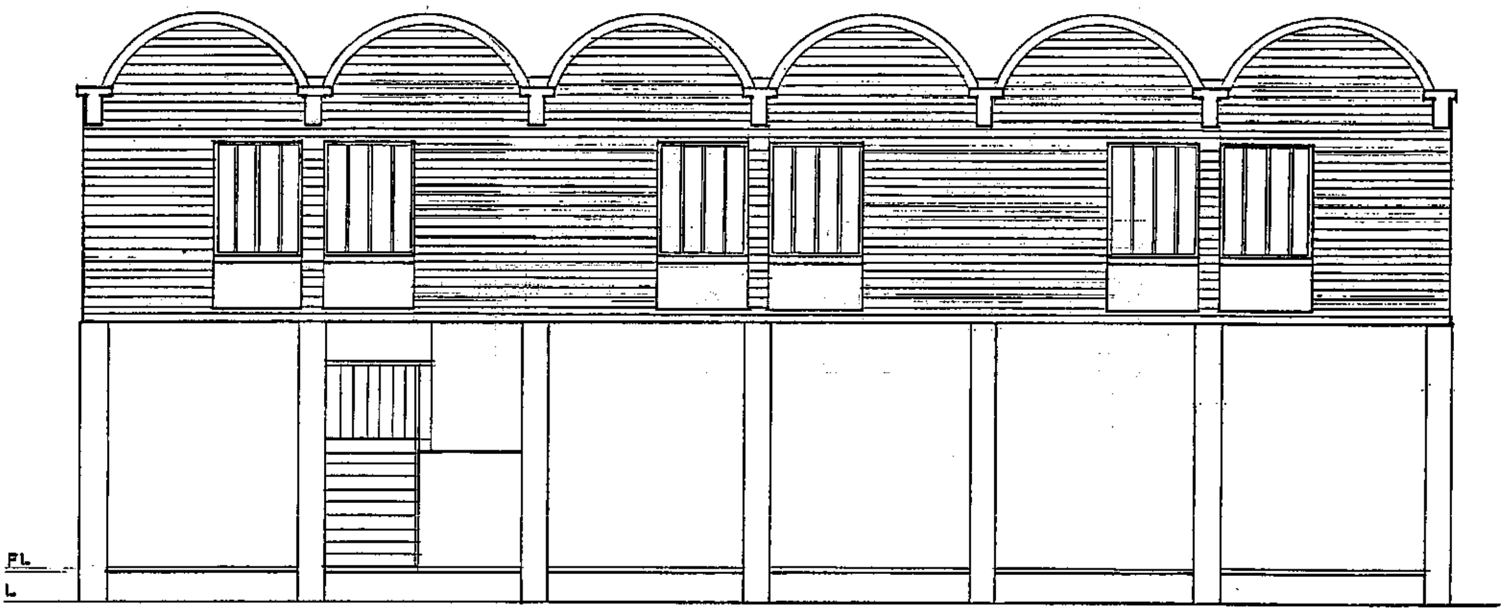


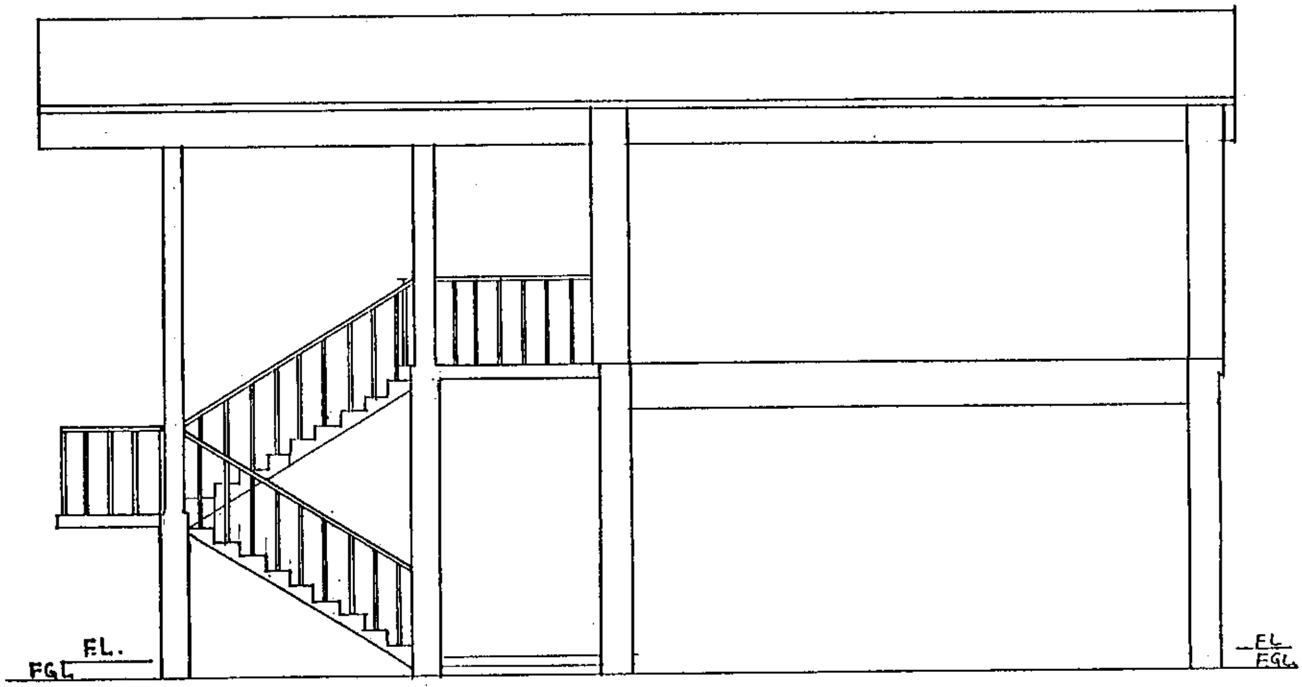
Figure 19. Type C. building for low ground: Arranged for refuge use

FRONT ELEVATION

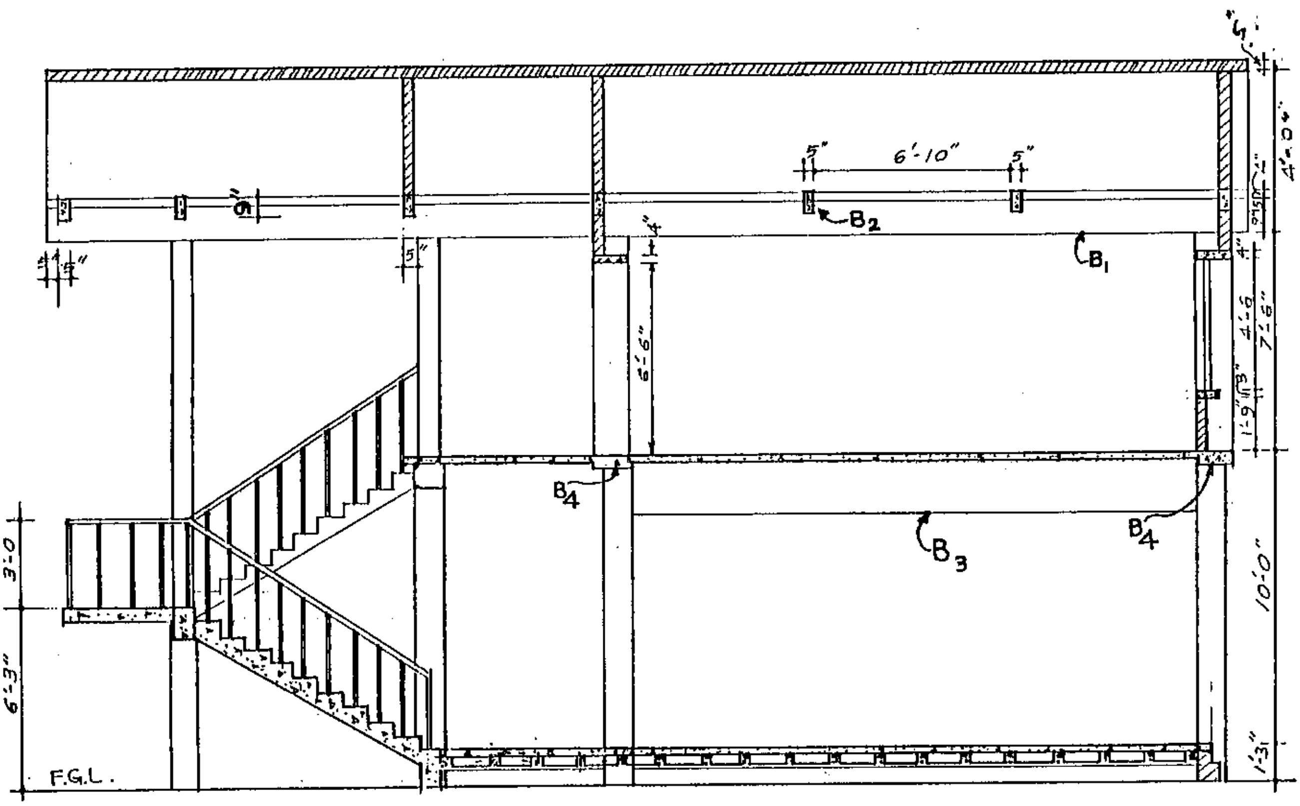


BACK ELEVATION

Figure 20. Type C. building for low ground: Elevations



SIDE ELEVATION



X-SECTION

Figure 21. Type C. building for low ground: Sections

CHPATER SIX: LATRINES

In the earlier UPE schools toilets have been provided with water seal pans and a system for alternating waste tanks. This design was suggested as it has worked very well in certain communities in countries which neighbor Bangladesh.

The UPE primary schools experience with these toilets has not been universally satisfactory. As the basic concept of a latrine is new to many Bangladesh villages people need to be taught how the toilets work, and how they can be kept clean and in working order. The water seal design requires the availability of water for each use and also presupposes that users will understand the principles of the water seal flush. Either such instruction is not given or goes unheeded. Many toilets are kept locked to keep them clean.

A simpler toilet to use is the "aqua privy" which does not need to be flushed after each use. It also requires infrequent cleaning. On the negative side, the aqua privy requires that a water tight tank be constructed and that the internal water level be maintained. Because of the complexities of building this tank, it is more costly than the currently constructed water seal design.

Figures 22 and 23 gives the plan and sections of an aqua privy.

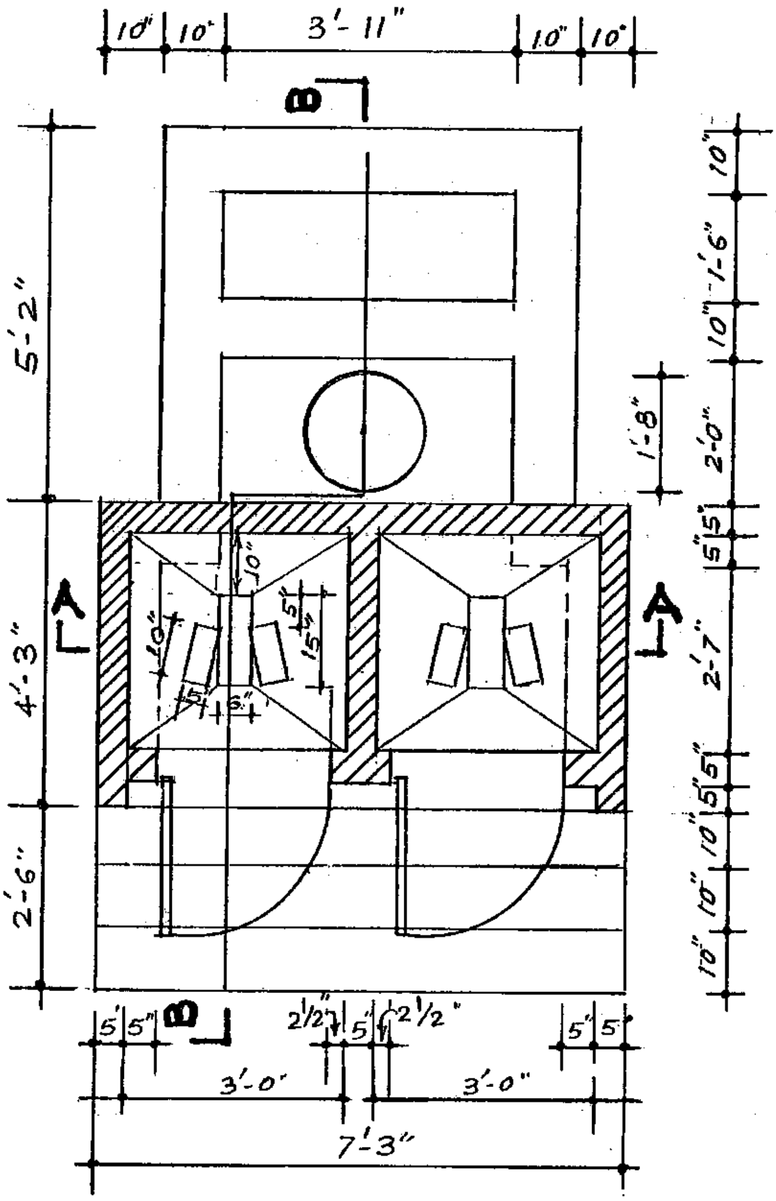


Figure 22. Aqua Privy: plan

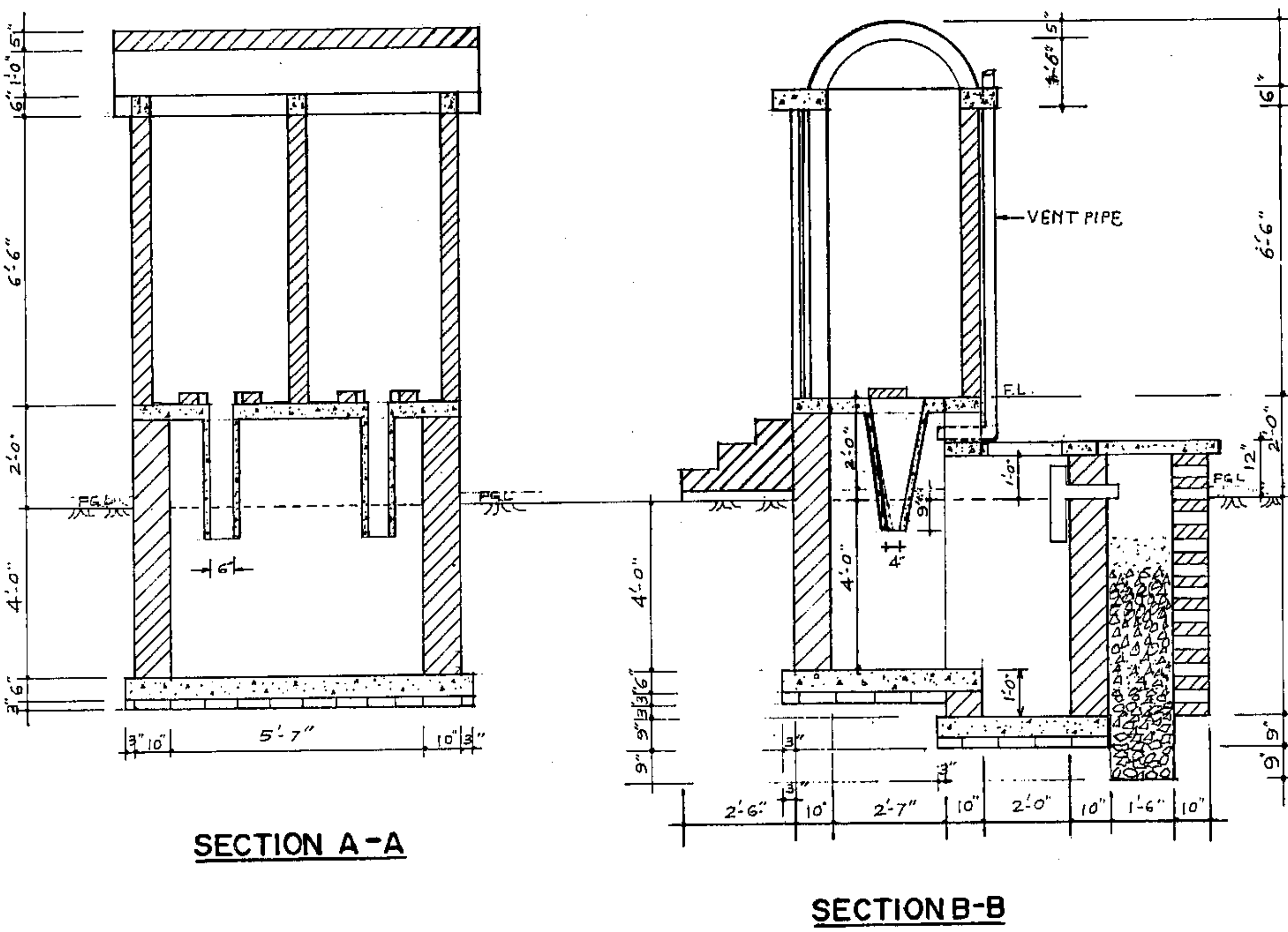


Figure 23. Aqua Privy: sections

CHAPTER SEVEN: COSTS

It is essential to keep the costs of primary schools in Bangladesh at a level affordable by the government.

There are two factors which effect the economic cost of educational buildings: the amount of space per pupil that is provided and the cost per square foot of that area which is constructed. Therefore in order to have a truly economic building the area per place, as well as the cost per square foot, must be kept low.

The present exercise has been carried out in the context of the present situation in Bangladesh and has aimed to keep the costs of the new schools cum refuge centres at the same level as the previous UPE buildings. This is not easily done as the provision of a refuge function in addition to the usual school function means additional requirements must be met. In most cases providing additional services means greater investment.

In Tables 8 and 9 a comparison has been made between the currently built UPE primary school and the new designs.

Table 8. Cost comparison of alternative designs

	Current UPE Design		Type A		Type B		Type C	
Capacity	288		336		336		500	
Area per place	5.53		5.97		5.97		6.20	
	Tks	US$	Tks	US$	Tks	US$	Tks	US$
Cost per sft	185/92	5.63	161/36	4.89	162/48	4.92	170/25	5.16
Cost per place	1027/77	31.14	860/12	26.06	866/07	26.25	1056/25	32.0

Table 9. Ranking of alternative designs

Ranking	Current	Type A	Type B	Type C
Area per place	1	2	2	3
Cost per sft	4	1	2	3
Cost per place	3	1	2	4

As can be seen from Table 8 building types A and B promise to be about 16% more economical per place than the currently used design. Type C, however, is estimated at 3% more expensive. While the area per place in all three new designs is superior to that of the current design all three are less costly to build per square foot. While the limited duration of the internship have not permitted a cross check on these costs, there is the promise that with the new designs Bangladesh may be getting more and spending less in comparison to current practices.

The aqua privy solution for the latrine is, however, expected to be double the cost of the current design. This substantial difference is the consequence of using a different technology. It is hoped that this extra expense may be justified by virtue of the fact that the latrines will less often go unused because they are fouled.

Annex 5 gives the summary data for each school building type and a detailed costing for building types A, B and C.

CHAPTER EIGHT: ACTION PLAN

The propositions contained in this report become valid ideas only when they have been field tested and adopted on a large scale. The government of Bangladesh may go on to construct several thousand buildings based on these designs. If massive construction is done directly on the basis of this study, any mistake in these designs, should there by any, will be multiplied thousands of times over. It is fundamental therefore, that a research and development (R and D) cycle be followed by constructing and evaluating several prototype buildings.

Figure 24 elaborates on the steps to be taken.

The current report will need to be presented to the Facilities Department for reactions. This should be followed up with the fabrication/construction of those elements which are new and for which field work is required to determine the best construction techniques. This will particularly apply to the new steel roof trusses and the brick barrel vaults. Several structural bays of each should be constructed and tested to destruction by qualified building research authorities.

This phase should be followed by a one week intensive training of the field engineers and overseers who would be charged to construct prototypes of type A, B and C buildings. These buildings should be evaluated by an interdisciplinary team which would study the following aspects.

- Functionality as an educational building
- Functionality as a flood refuge
- Appearance and community acceptability
- Ease of construction
- Cost
- Durability

Once that report is submitted, certain design changes may be required. Once these are made a large scale training activity is required for all levels of personnel who will be involved in project execution from executive engineers down to site overseers and even masons.

Due to the climatic seasons in Bangladesh buildings are normally constructed during about one half of the year. The monsoon season presents an excellent opportunity to evaluate the results of the previous years' work and a modification of the design.

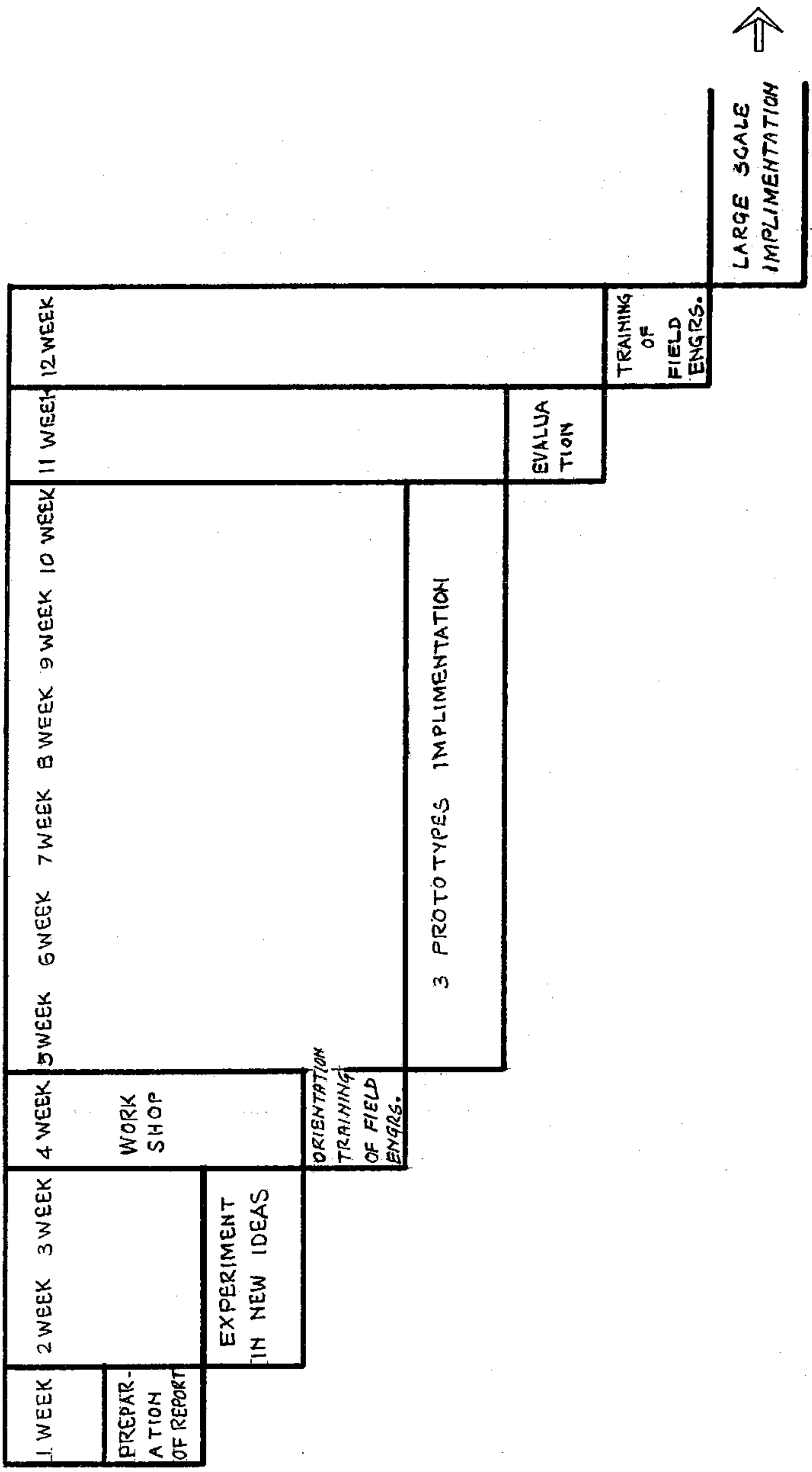


Figure 24. Action plan

Annex 1. School designs for coastal flood areas.

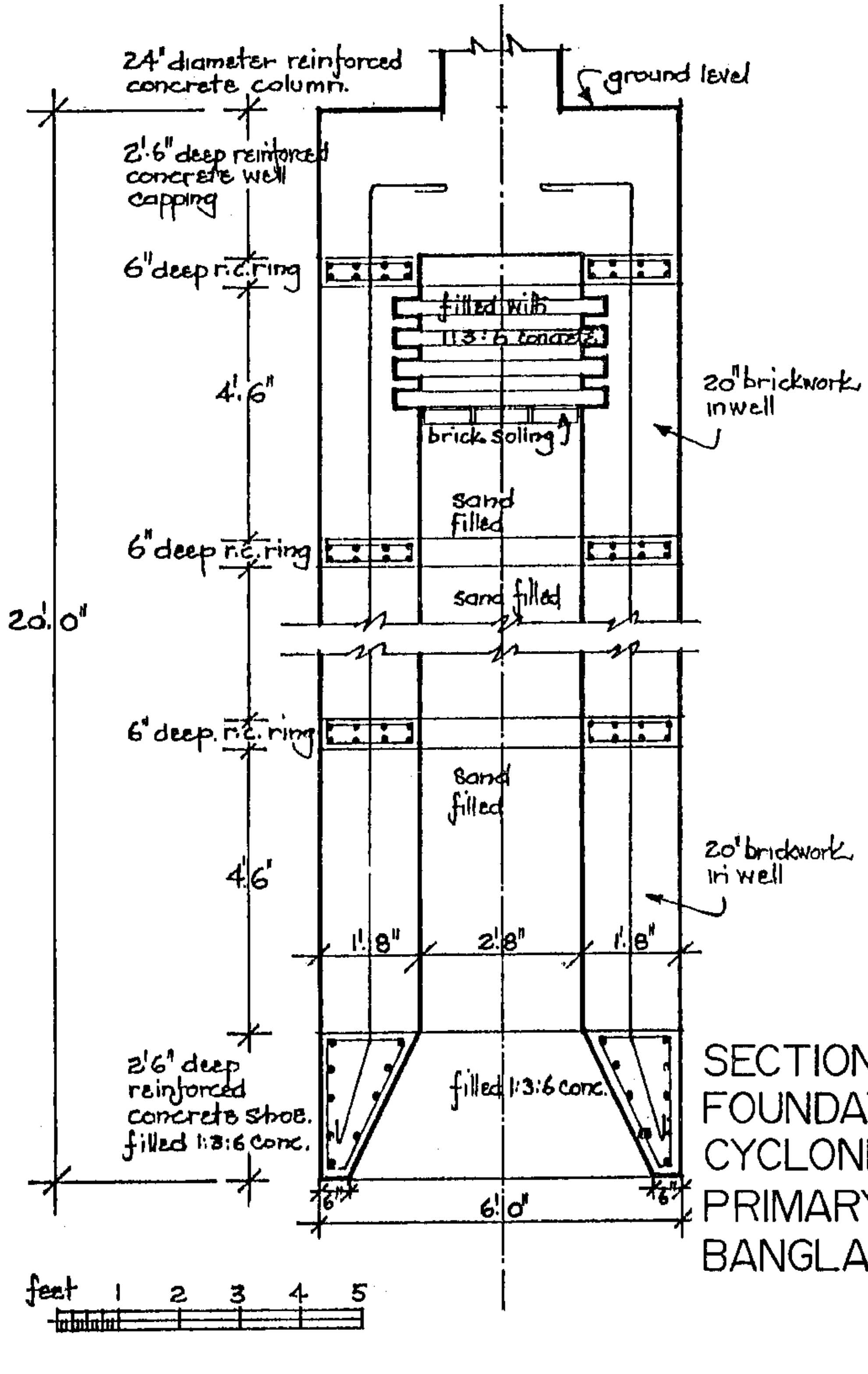
A. School Buildings and Natural Disasters by D.J. Vickery, Unesco, Paris, 1982.

B. Designs for Coastal Areas in Bangladesh, Unesco, Bangkok, 1979.

C. Government Primary School at Coastal Areas. Facilities Department, Ministry of Education, Bangladesh, 1984.

D. Primary School (near) Coastal Area. Facilities Department, Ministry of Education, Bangladesh, 1984.

E. Noakhali Coastal Region: Primary School/Cyclone Shelter. RDRS/LWS, Bangladesh, 1985.



SECTION:WELL FOUNDATION CYCLONE PROOF PRIMARY SCHOOL BANGLADESH

Annex 1. A. School Buildings and Natural Disasters by D.J. Vickery, Unesco, Paris, 1982.

The school as a refuge in areas of severe tropical cyclones

The focus of this discussion is the school. How many people are there to each primary school? Or, to put the problem another way, in the event of a disaster, how many people would seek refuge in a disaster-resistant school?

The answer required is an approximation. It may be obtained quite simply from local-authority statistics, or, very approximately, by multiplying the enrolment of the village primary school by a factor of three. Thus, if the enrolment is 150 children, the catchment area from which the children are drawn will have, very roughly, a population of about 450 persons.

Thus in a severe tropical cyclone, a cyclone-resistant rural primary school might have to provide refuge for three times as many people as there are children enrolled.

At worst, the time taken by an 800-km-diameter cyclone to pass would be some thirty-two hours (if it was moving forward at 25 km per hour). If the eye of the storm is moving forward faster than 25 km per hour, then this time would be reduced. In the case of the Chittagong cyclone mentioned above, the time spent in the refuge was fourteen hours as the cyclone was moving forward at a greater speed—probably some 50 km per hour.

How will the people taking refuge in a cyclone-resistant school be organized, how will they pass the time, what will they do?

The answers to these questions will be largely dictated by the money available. Many of the vulnerable countries have insufficient resources to pay for the construction of even the simplest schools. The 600 rupees for the school at Nanpur in Orissa, mentioned earlier in this chapter, may be very low—it was worth some U.S. $60 at the time. Nowadays in India, for example, about $1,500 might be found for a new primary school in some states of the Union. Other countries have more or fewer resources but very few of the vulnerable countries are wealthy enough to provide elaborate school buildings. Therefore it may be assumed that if the school is to be used as a refuge any extra money available will be invested principally in making it cyclone-resistant. The refugees thus may have to occupy the building as it is—designed for education.

Where there are severe cyclones, there are often floods and hence the need is to construct two-storey schools.

If a rural primary school is to house, say, 150 children, then its area should be approximately 150 m^2. Each floor should be 75 m^2 and the upper floor would house the population of 450 (3 x school enrolment) thus giving an area of 75 ÷ 450 m^2 per person = approximately 0·2 m^2. Every square metre would be occupied by five persons. Figure 19 shows this to be possible in the standing position with room to spare.

In fact, eight adults could stand in one square metre of floor space.

Most, however, would prefer to squat. In this position, as is shown in Figure 20, two and a half adults could be accommodated.

About one-third of the people in the population would be children, who are physically smaller. So a normal rural school would probably, while offering no comfort at all, be just large enough to house the people from the catchment area it serves.

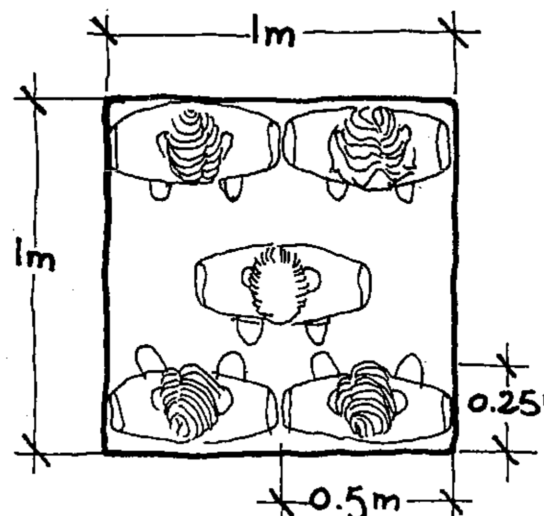


Fig. 19. Five adult males stand in one square metre

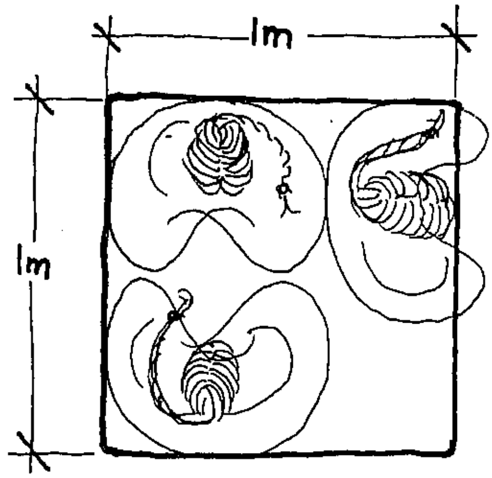


Fig. 20. Two and a half adult females squat in one square metre

The drawings also suggest that very limited movement might be possible, enabling people to edge their way to a toilet area and to a place where drinking water facilities would also be available. The toilet would comprise nothing more than a space with holes in the floor. Indeed, many of the villagers may be unfamiliar with toilets.

From this discussion, it is possible to list the design requirements for a rural primary school which is intended to serve also as a refuge in a severe tropical cyclone:

1. A cyclone-resistant building, i.e. a building constructed to resist wind forces of up to 240 km per hour.
2. One floor raised 2 m above anticipated flood/wave level; designed to carry a load of densely packed people.
3. The foundations and columns able to withstand surging water.
4. Upstairs windows well shielded from direct wind.
5. Water storage at the upper storey.
6. A small, screened area at the upper storey with holes in the floor, for use as a toilet.
7. A good staircase with secure handrail.

The lower floor may, in the humid tropics, be quite open and this, indeed, is desirable so that flood waters can sweep through without resistance.

Figure 21 illustrates the general floor plans of a small, cyclone-resistant primary school.

Figure 22 shows one of the two rooms at first-floor level occupied as it would be in a cyclone.

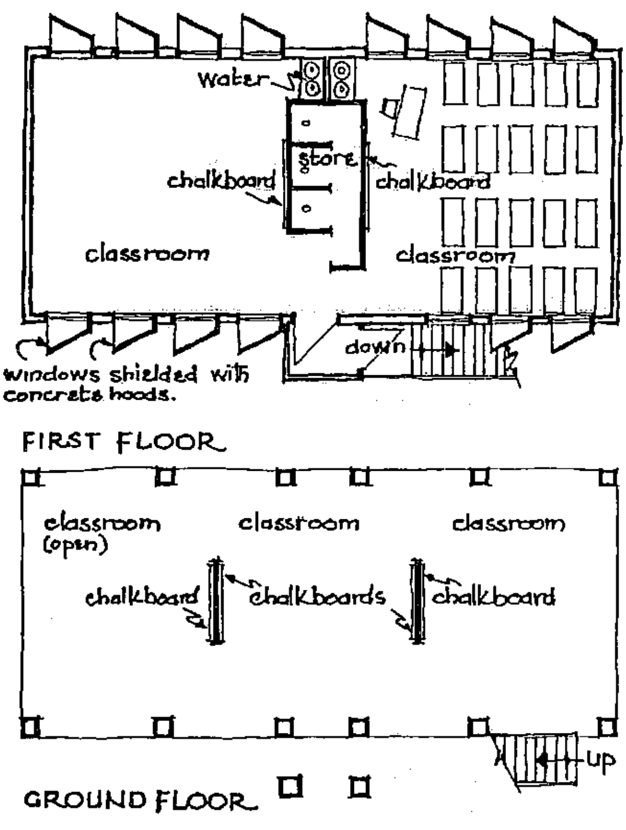


Fig. 21. Plans of a small, cyclone-resistant primary school

The school as a refuge after earthquakes and cyclones

A common feature of reports on disasters is the lack of communication that occurs in the immediate post-disaster period. Roads are washed out by cyclones, while earthquakes destroy or damage bridges and bring about landslides that block roads [5, 6, 7]. *This suggests the need for a degree of self-sufficiency in the (remoter) areas affected by disasters.*

If the school building is designed to be disaster-proof, then almost every village will have a focal point for relief activities.

It has to be stressed, however, that in most of the vulnerable countries the cost of constructing such schools would have to be borne in part by external financing, for the burden of building even the most simple school is, for many countries, too much.

If such schools could be built, what form might they take? It must be remembered that a disaster is a rare occurrence. The designer's approach, therefore, would be to design a school that could act as a relief centre, rather than a relief centre that acts as a school. Fortunately, there are common features. All schools should be provided with toilets and with safe water, although many have neither. The construction of toilets and the supply of clean water would thus serve the dual function of developing educational as well as relief activities.

Secondly, every school should have some simple facility for cooking. Nothing more is needed than a hearth and a chimney. Again, such a feature would be useful for school feeding programmes as well as for relief feeding if that becomes necessary.

Finally, there should be a good store in every school. Necessary for educational supplies, such a store would also be invaluable for temporary food and clothing storage after a disaster.

These three items—toilets and water, cooking facilities and storage—would add little to the cost of what will, in any case, be a more than usually expensive building and might greatly reduce the misery of the surrounding community in the interval between the disaster and the arrival of more substantial relief from government.

The school to protect children during disasters

If government is unable or unwilling to assign this dual function to school buildings on a national basis, or if other buildings are provided for the relief function, then there still remains the important task of ensuring that the school buildings themselves remain safe *during the disaster.* The technology to achieve this objective is available. The problem is usually to acquire it and use it—and that is precisely what this study is about.

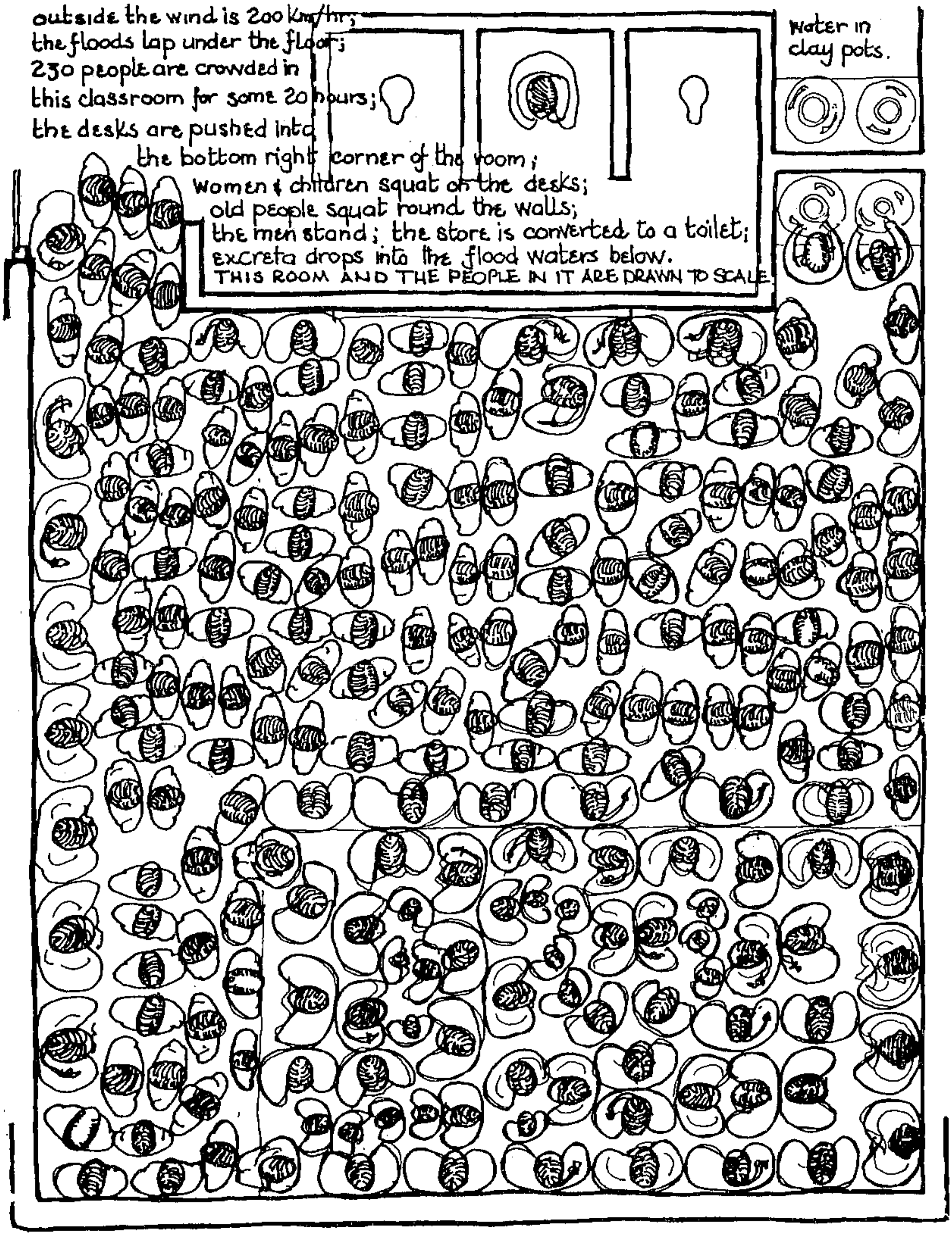
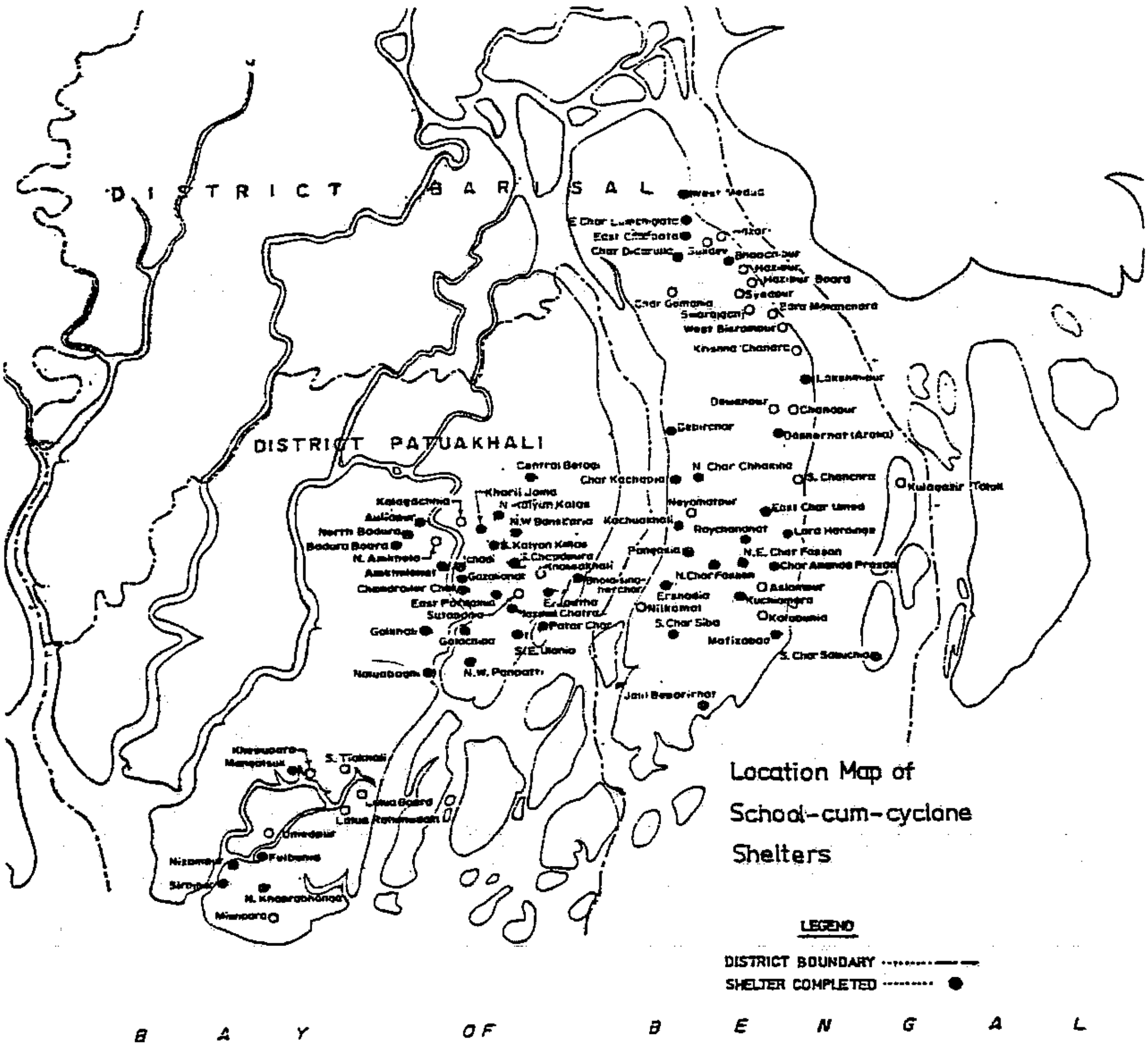
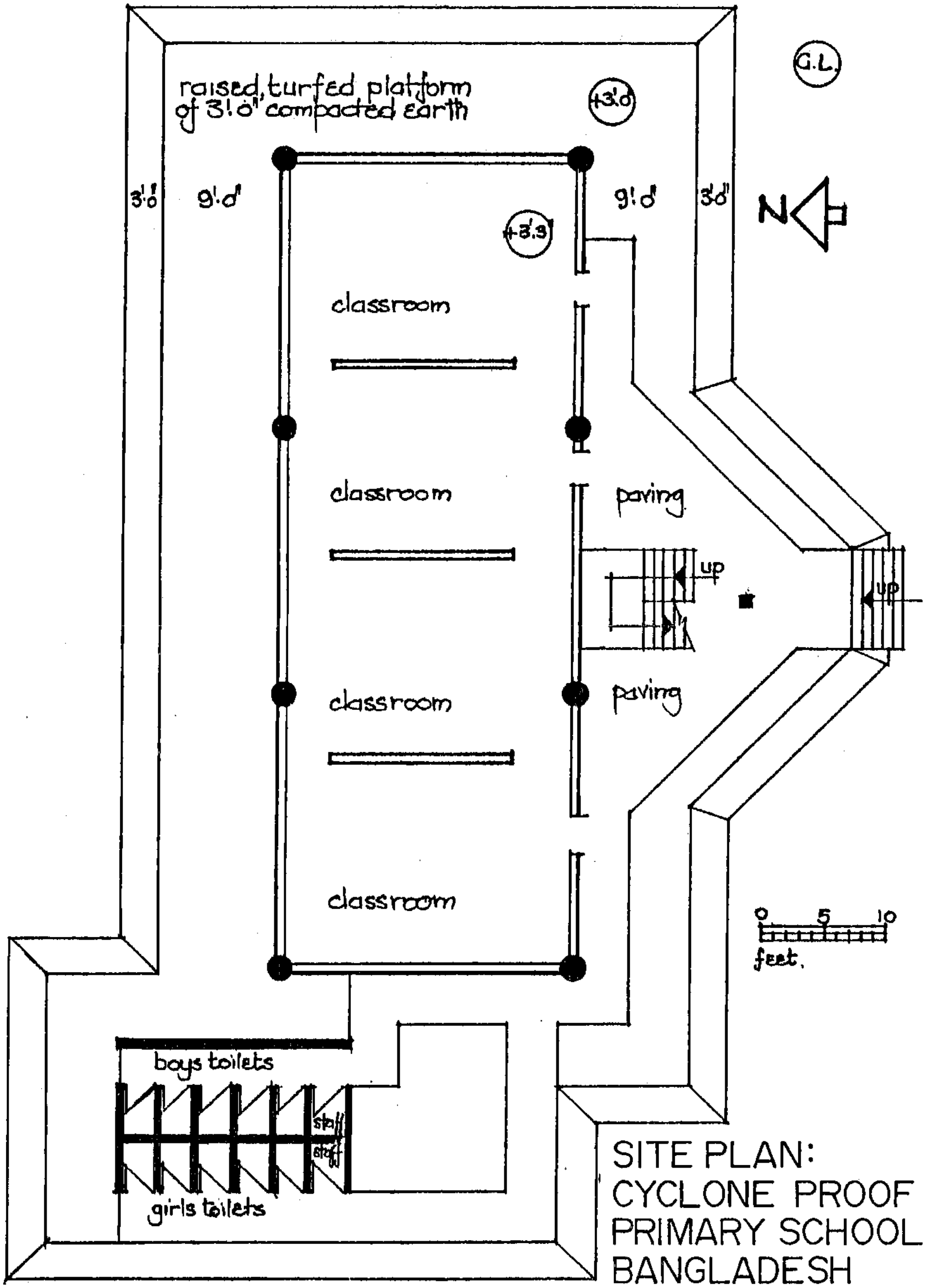


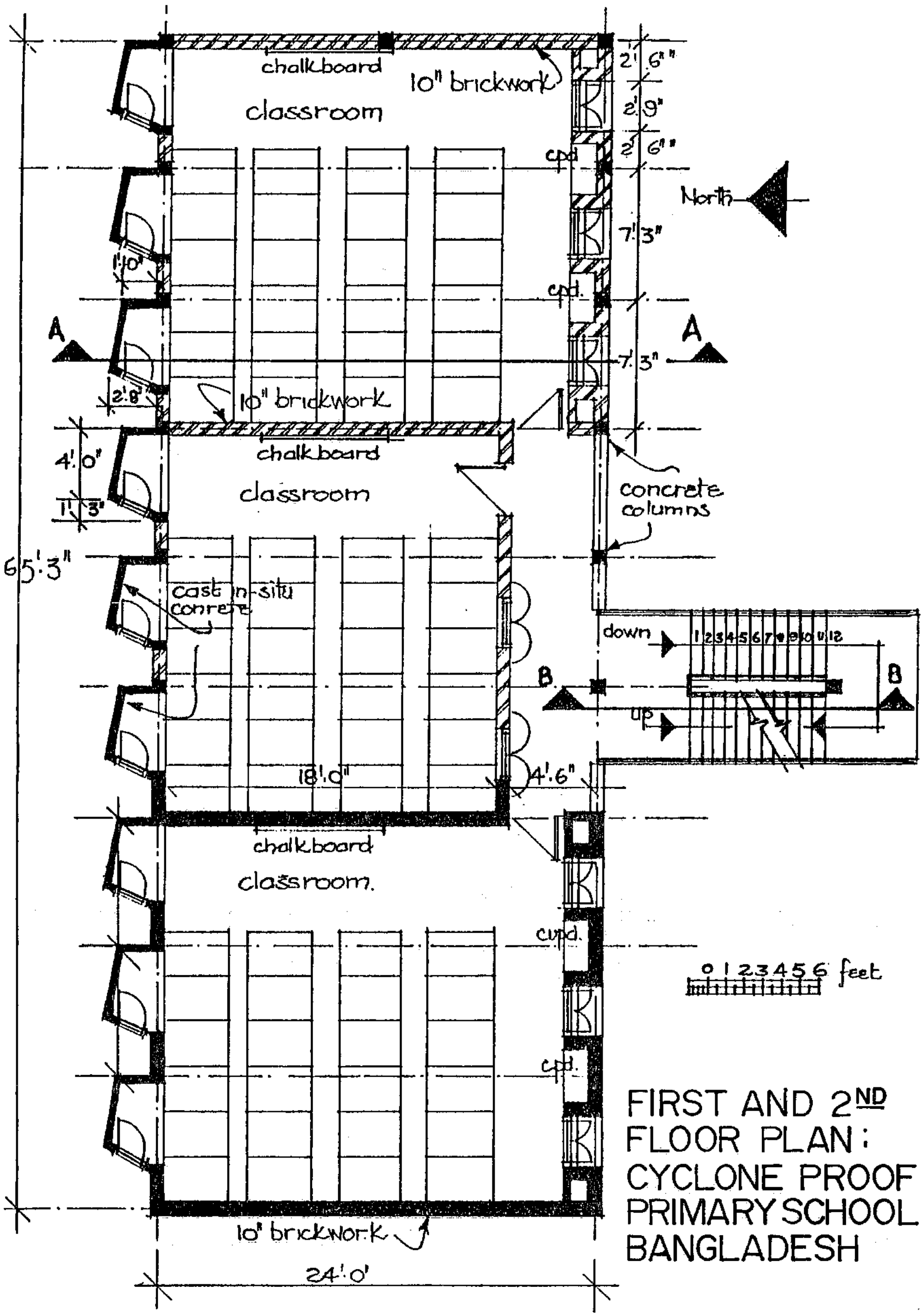
Fig. 22. One of the rooms occupied during a cyclone

Annex 1. B. Designs for Coastal Areas in Bangladesh, Unesco, Bangkok, 1979.



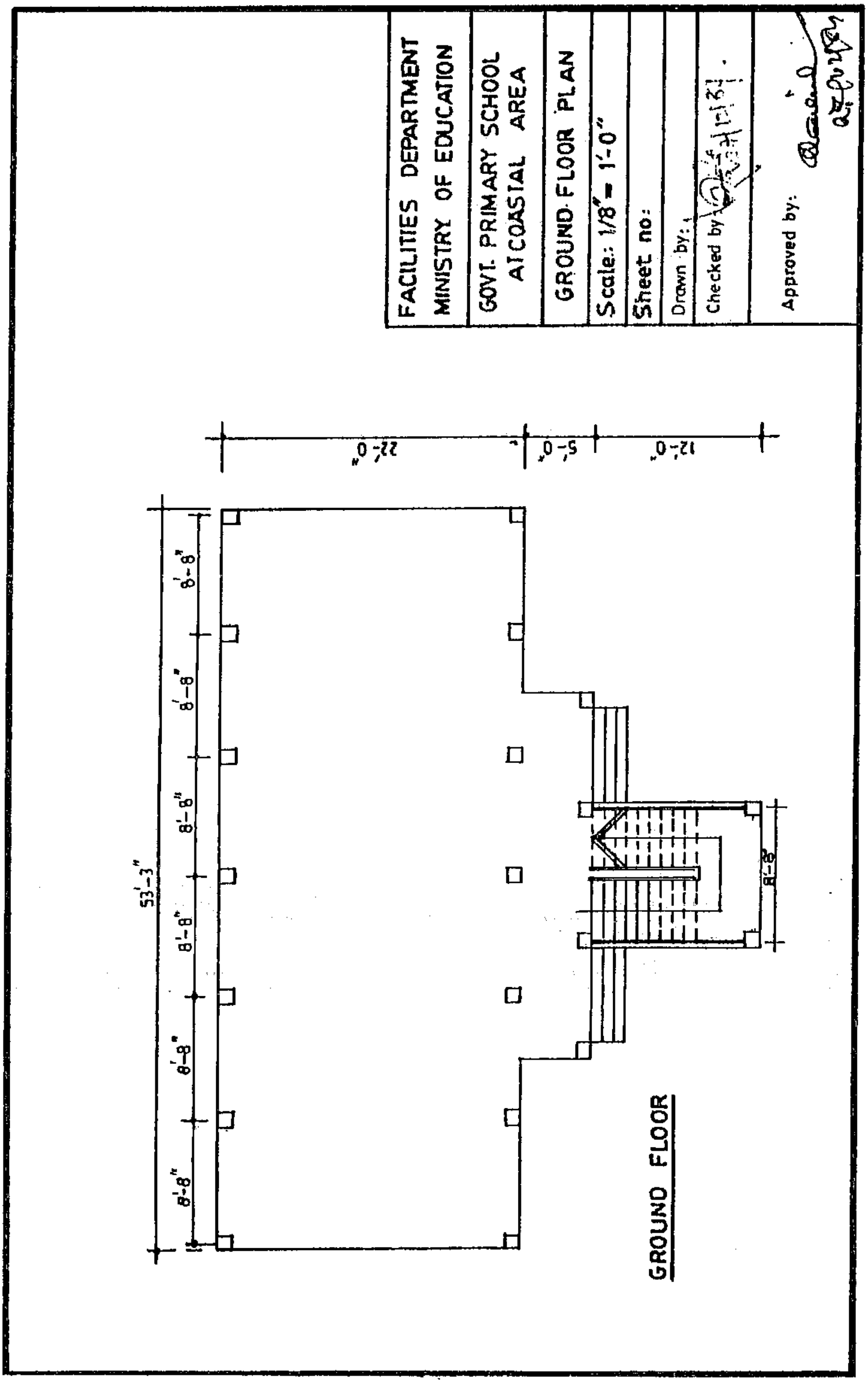


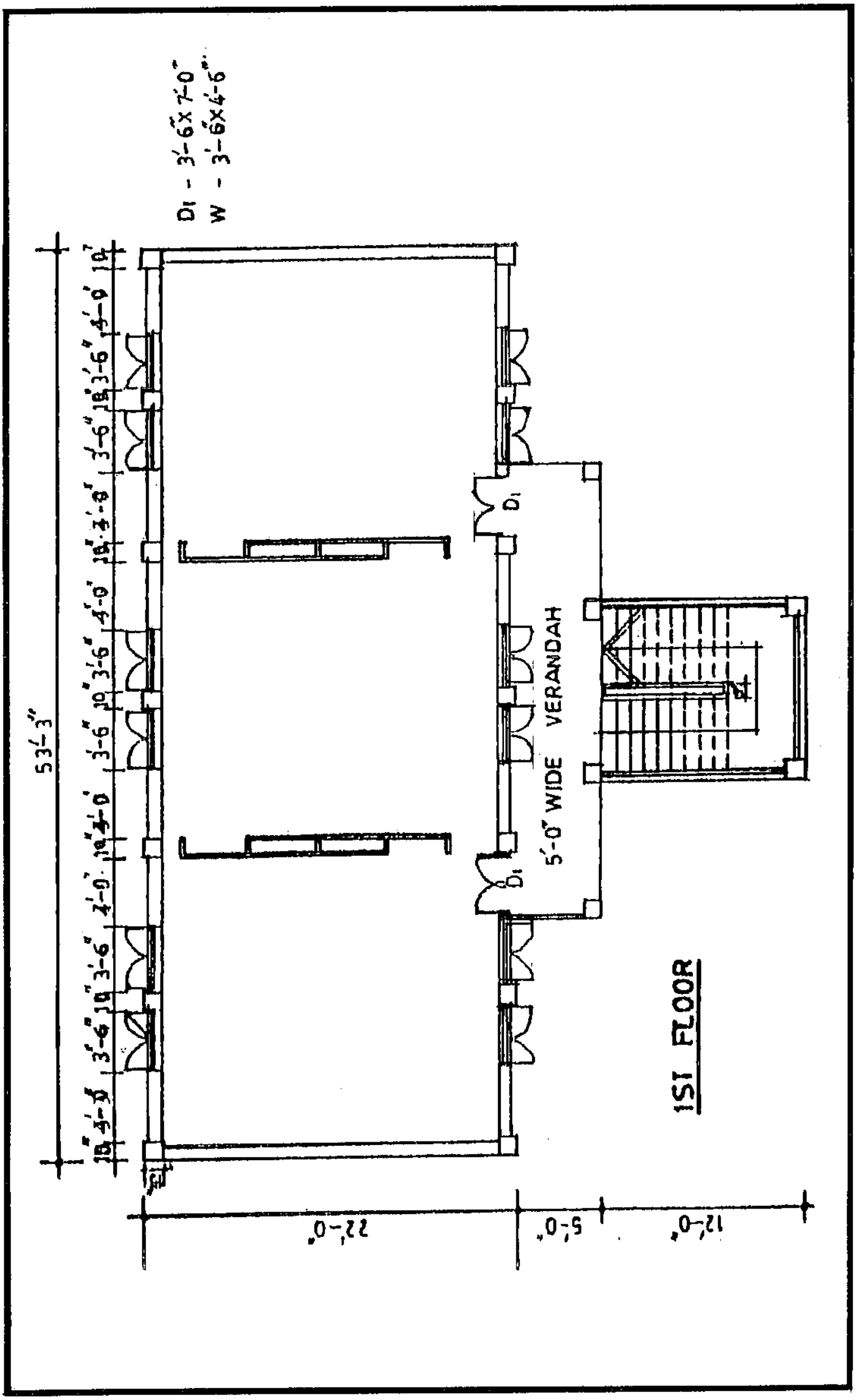
SITE PLAN:
CYCLONE PROOF
PRIMARY SCHOOL
BANGLADESH

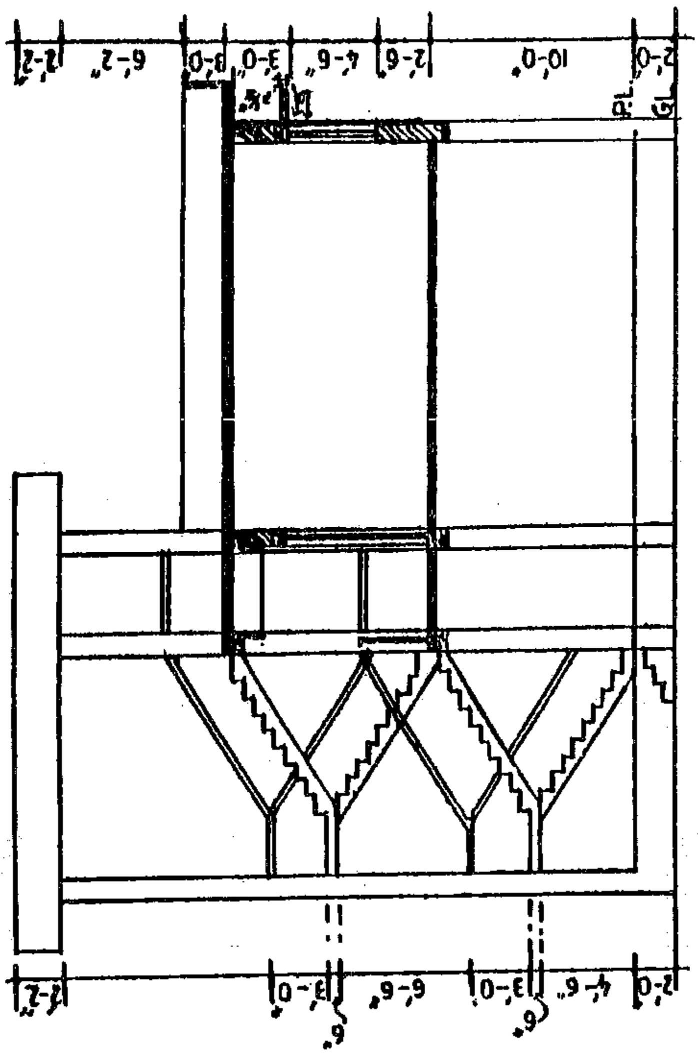


FIRST AND 2ND FLOOR PLAN: CYCLONE PROOF PRIMARY SCHOOL BANGLADESH

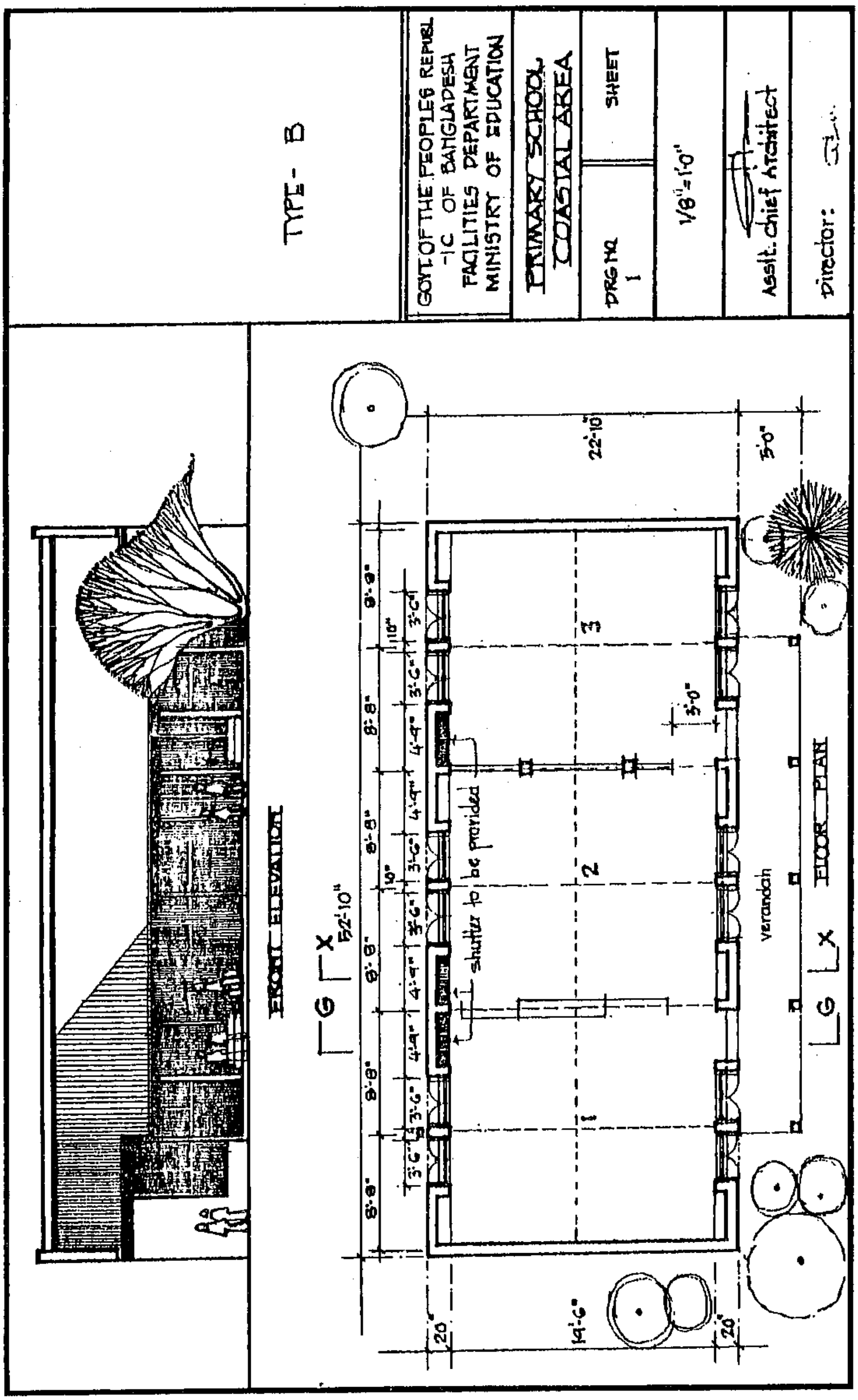
Annex 1. C. Government Primary School at Coastal Areas. Facilities Department, Ministry of Education, Bangladesh, 1984.

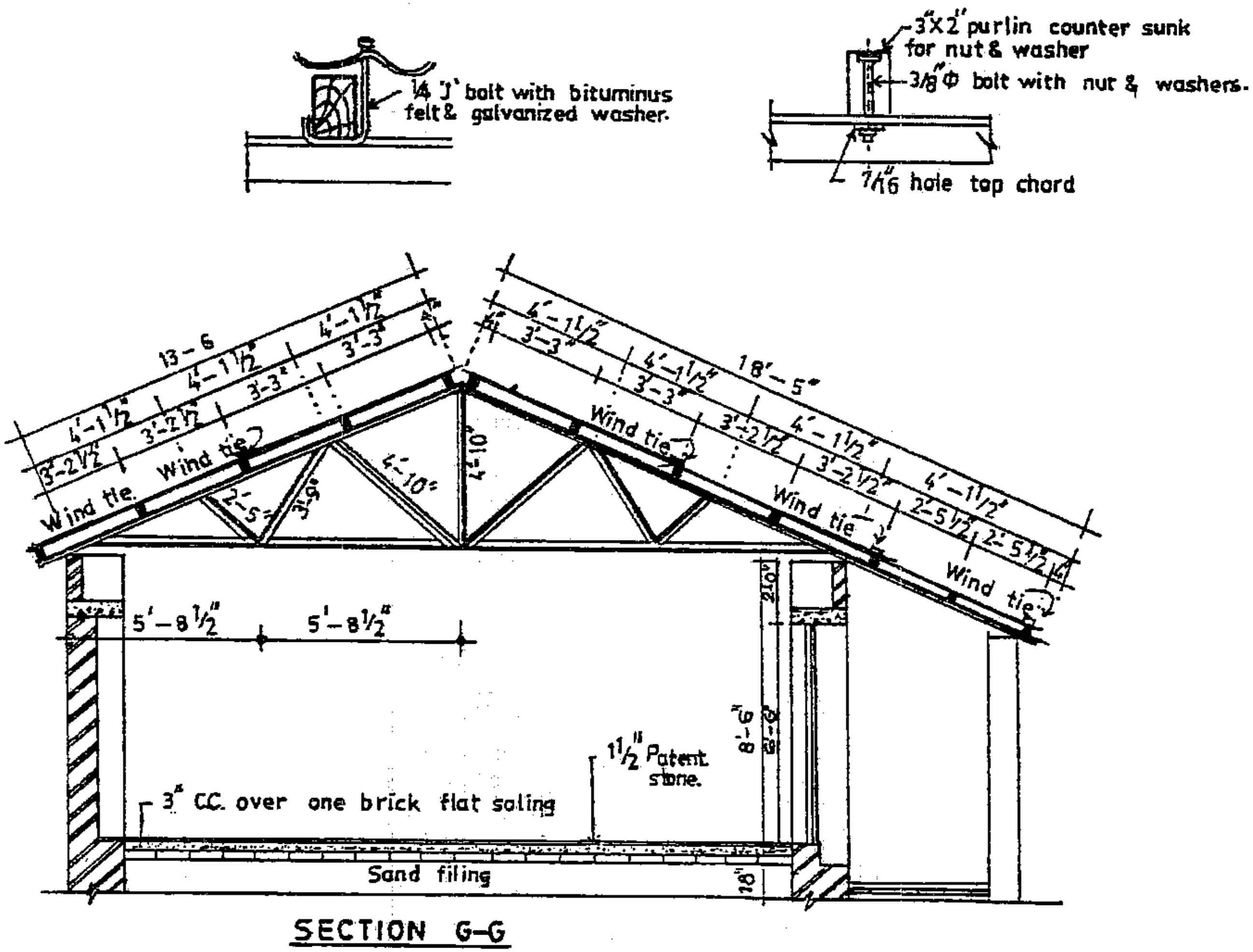



D1 - 3'-6"X 7'-0"
W - 3'-6"X4'-6"
53'-3"
5'-0" WIDE VERANDAH
D1
D1
1ST FLOOR
22'-0"
5'-0"
12'-0"



Annex 1. D. Primary School (near) Coastal Area. Facilities Department, Ministry of Education, Bangladesh, 1984.

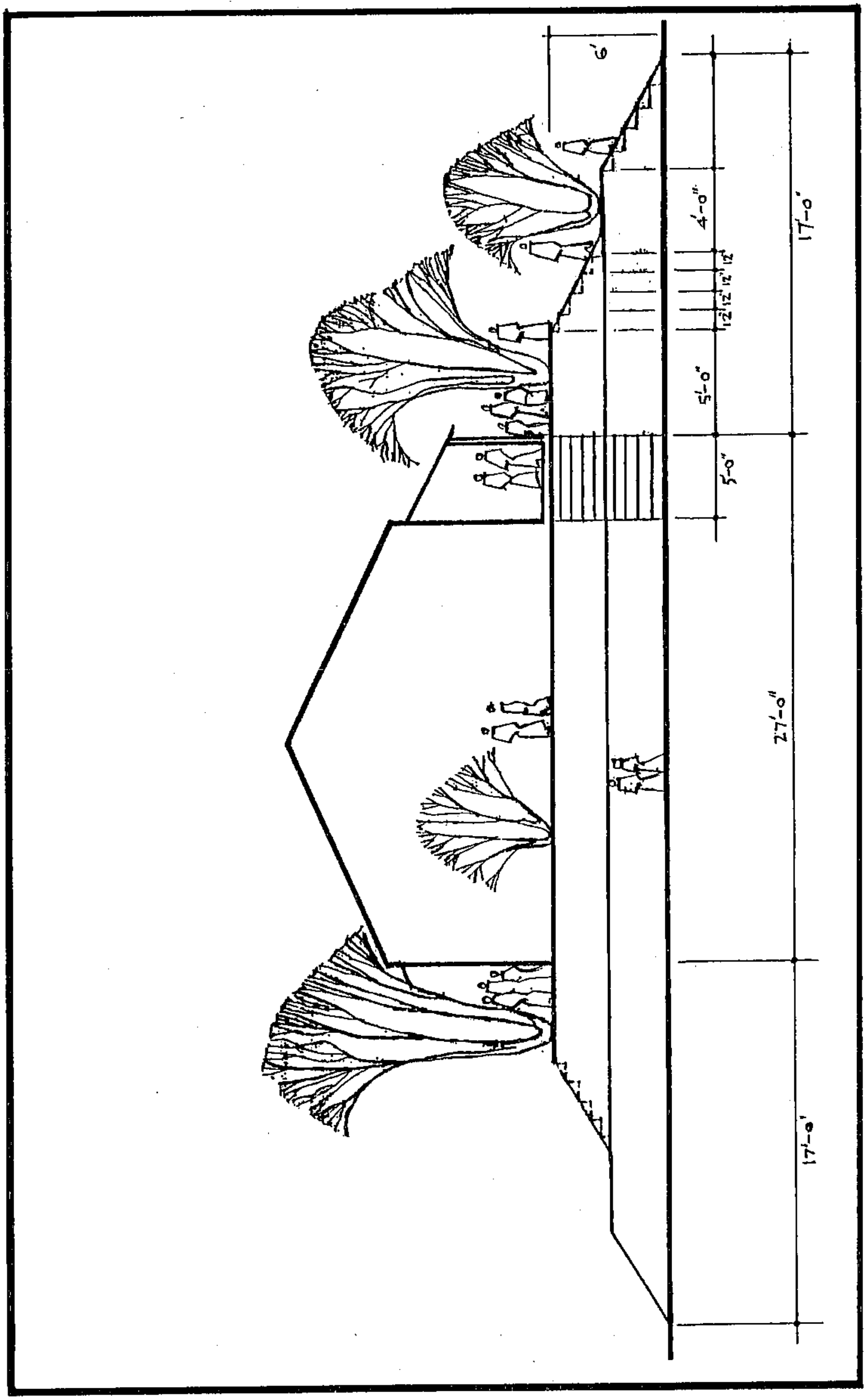




NOTE

1. All purlins are 2"X2"
2. Rafter size 2"X2"X1/4"
3. 1/4"X10"X10" iron plate to be provided on column top.
4. CI. sheet size 6'-0", 7'-0" long
5. 1 1/2" patant stone to be provided in floor and verandah slab.
6. 4"X 4"X 1/4" iron plate to be provide on veranda column top.

FACILITIES DEPARTMENT MINISTRY OF EDUCATION
PRIMARY SCHOOL AT COSTAL AREA UNDER U.P.E.NATIONAL PROJECT
DATAILS OF TRUSS
DRG. NO: SHEET NO
DRAWN BY:
CHECKED BY:
APPROVED BY:


6'
4'-0"
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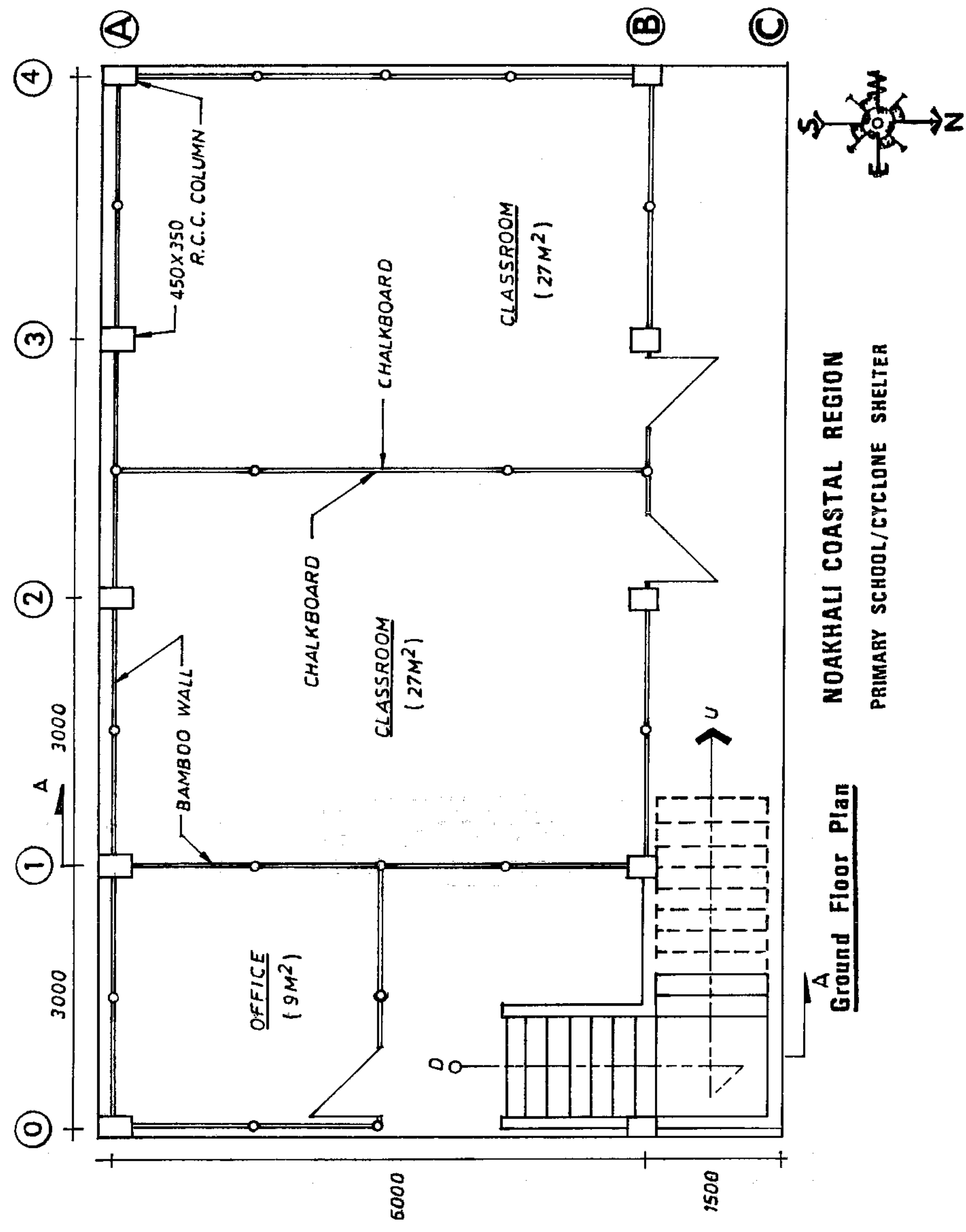
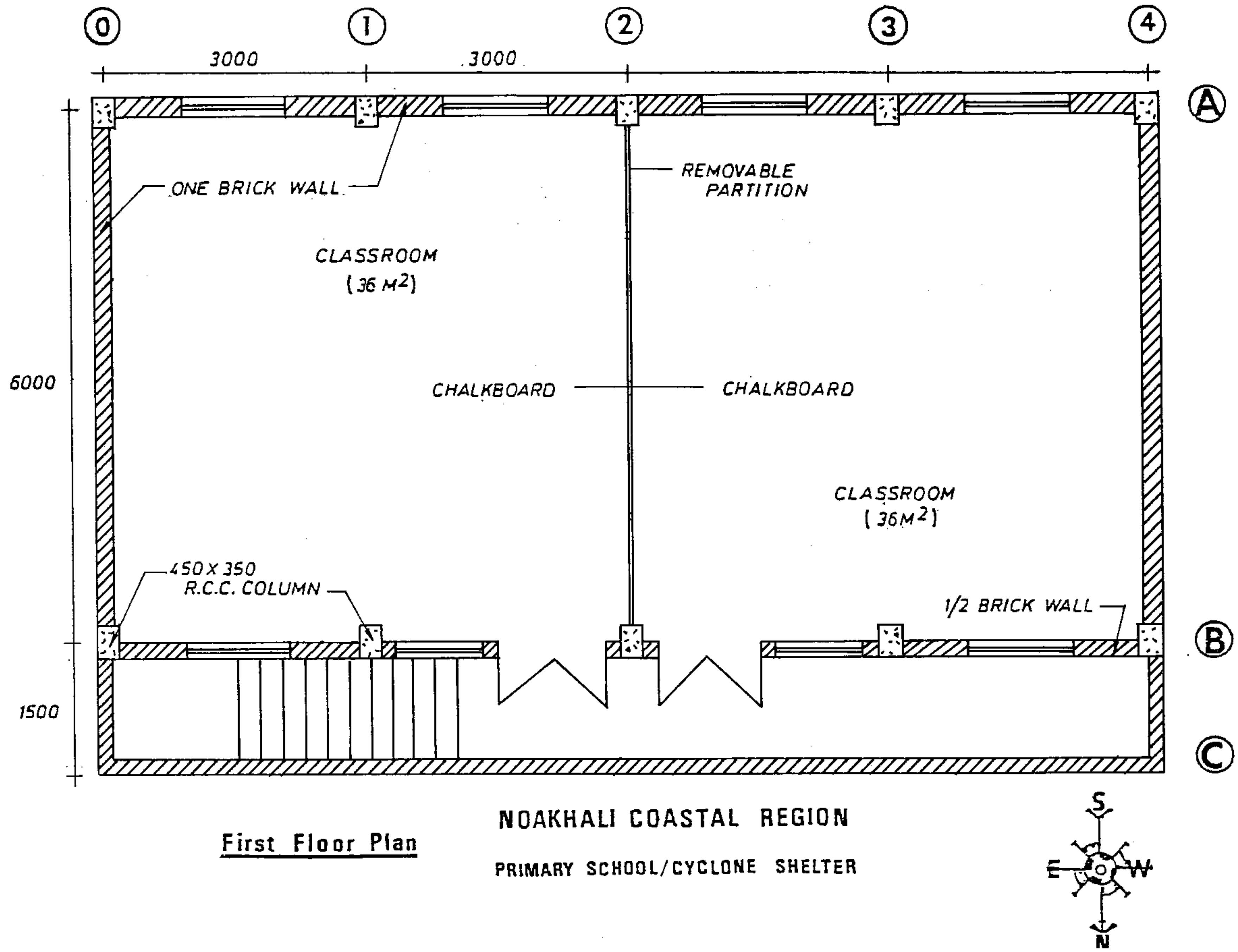
12' 12' 12' 12'
5'-0"
5'-0"
27'-0"
17'-0"

Annex 1. E. Noakhali Coastal Region: Primary School/Cyclone Shelter. RDRS/LWS, Bangladesh, 1985.

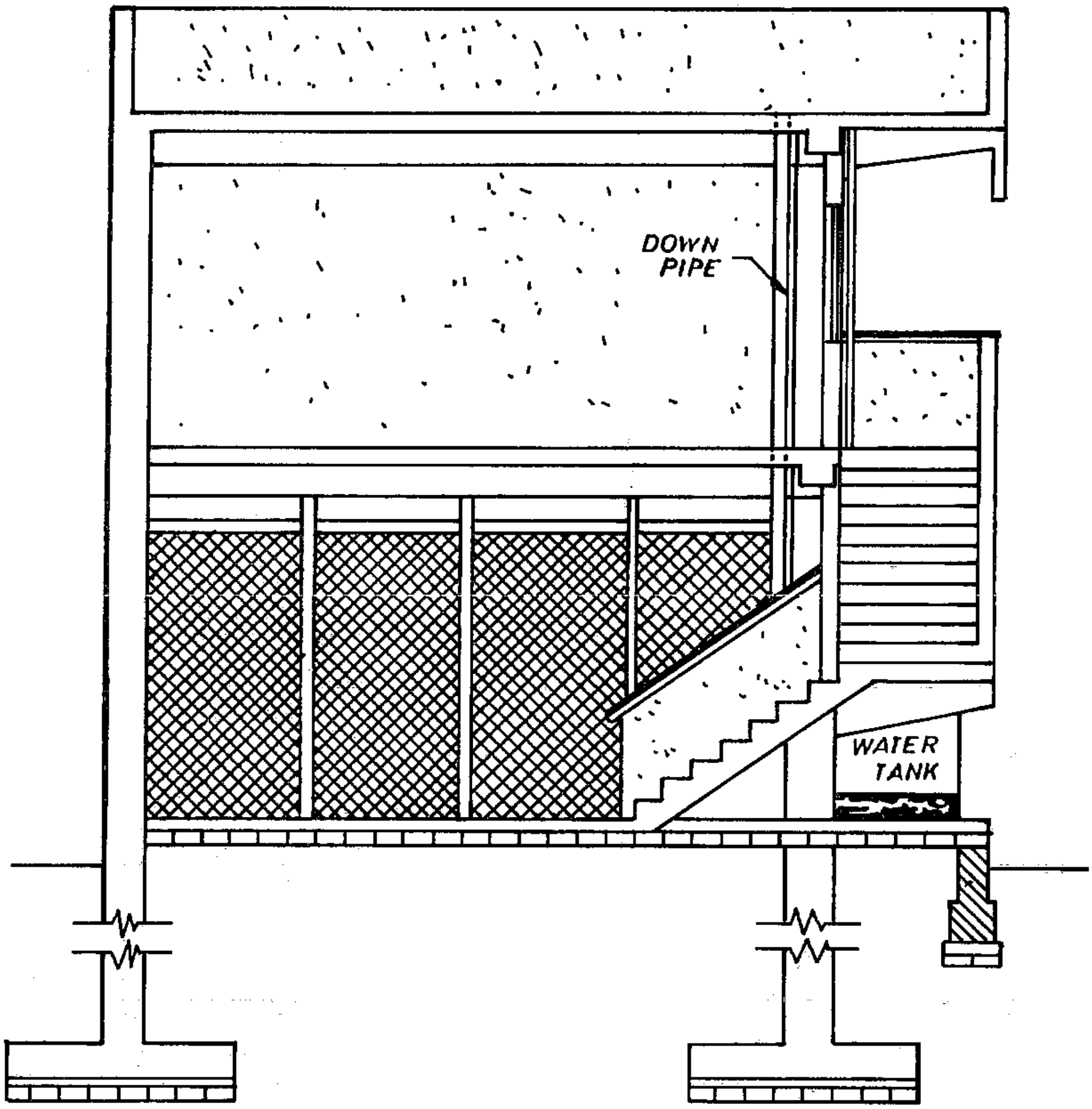




NOAKHALI COASTAL REGION

PRIMARY SCHOOL/CYCLONE SHELTER

First Floor Plan

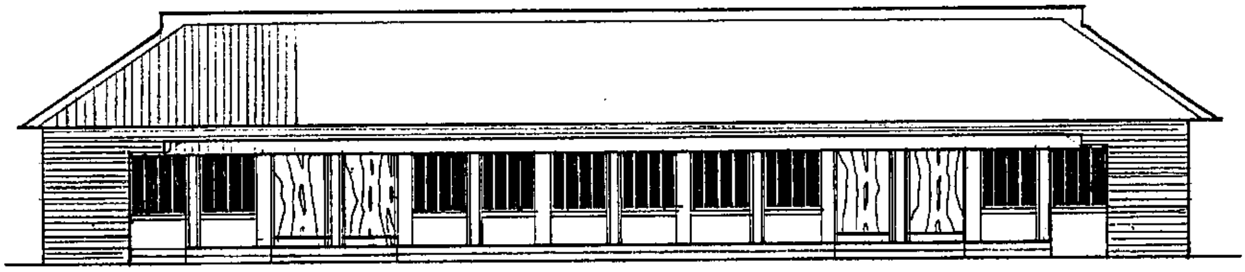


Section A–A scale 1:50

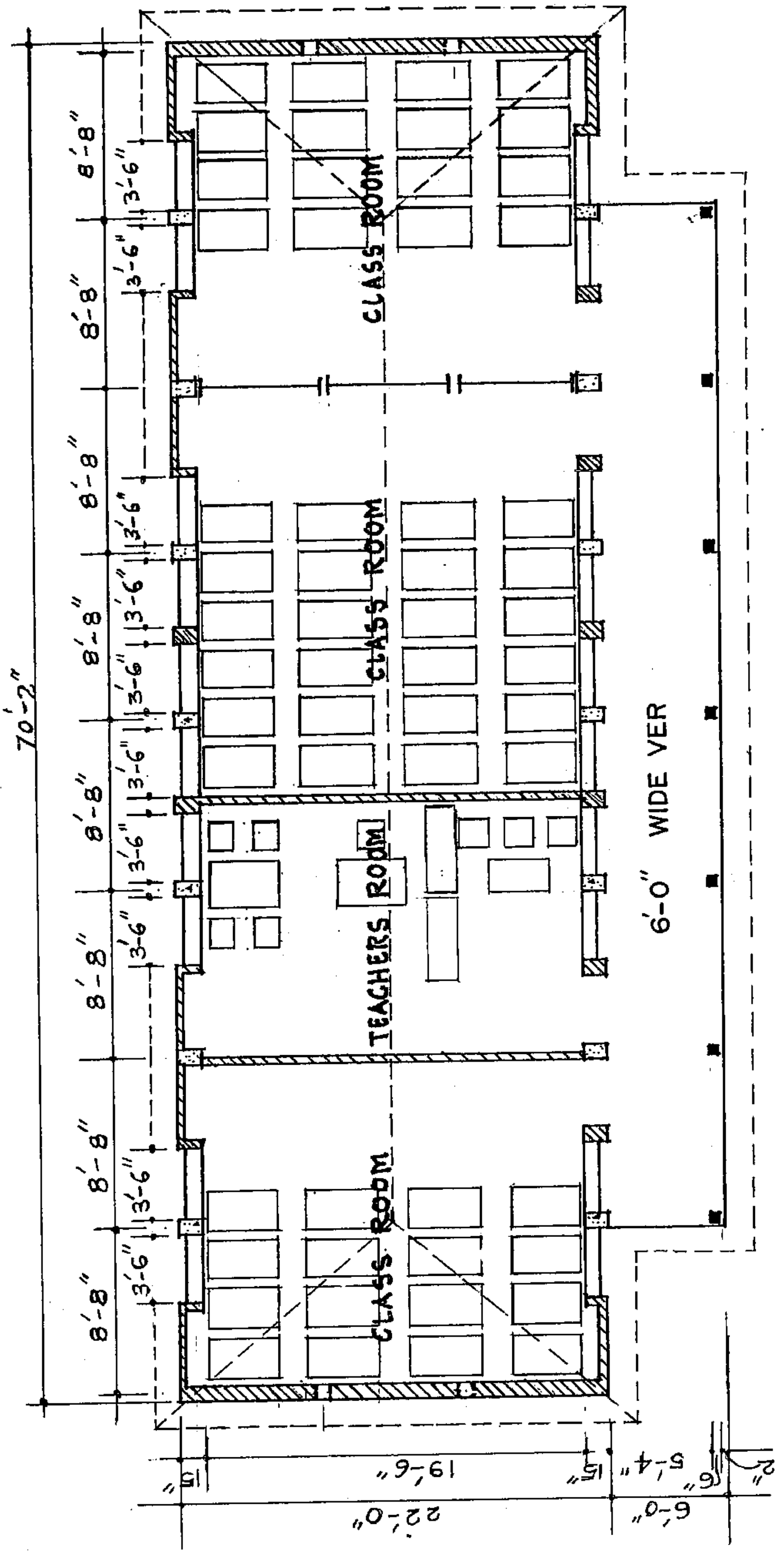
NOAKHALI COASTAL REGION

PRIMARY SCHOOL/CYCLONE SHELTER

Annex 2. Type A. School: Detailed drawings

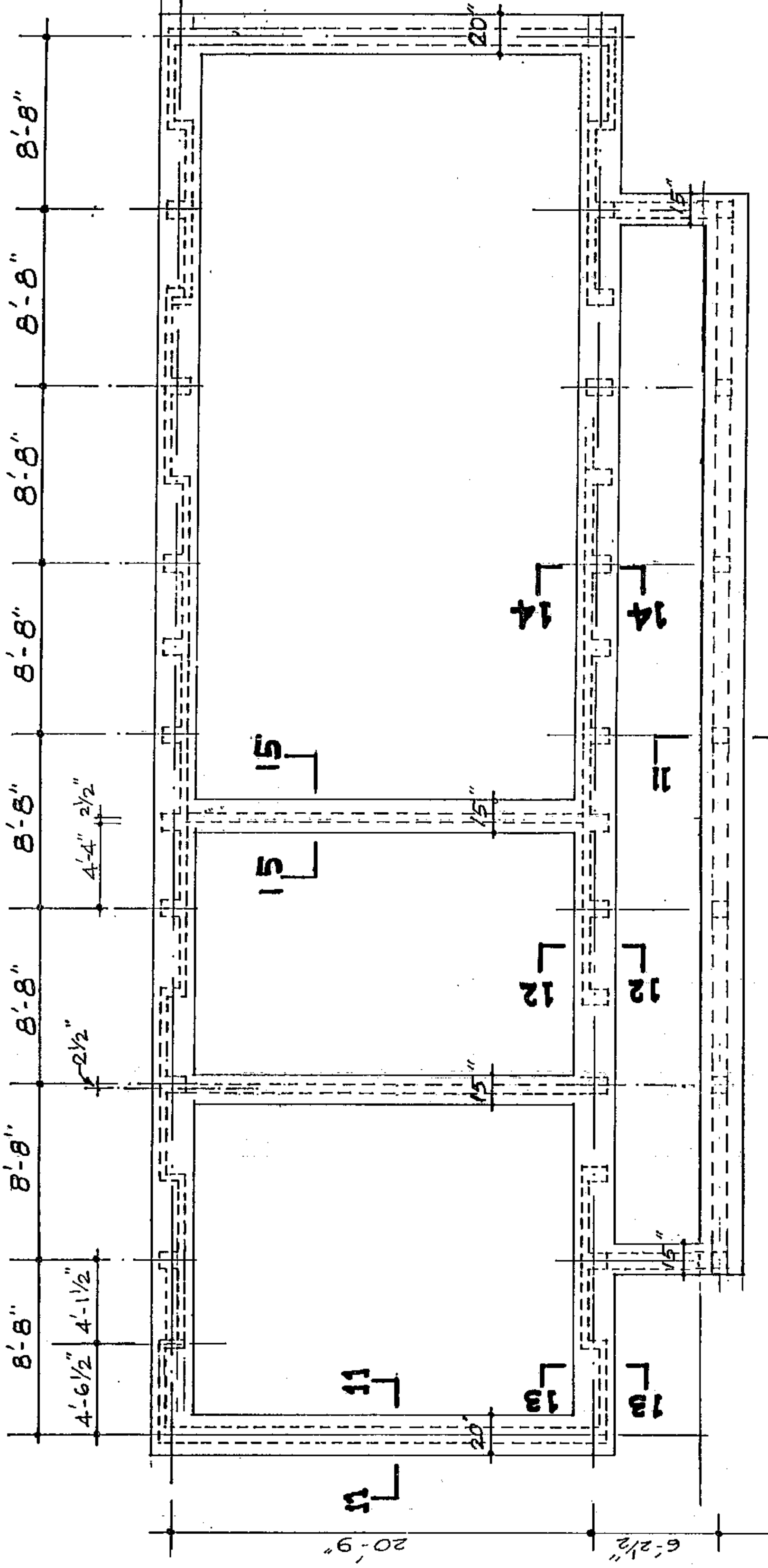


FRONT ELEVATION



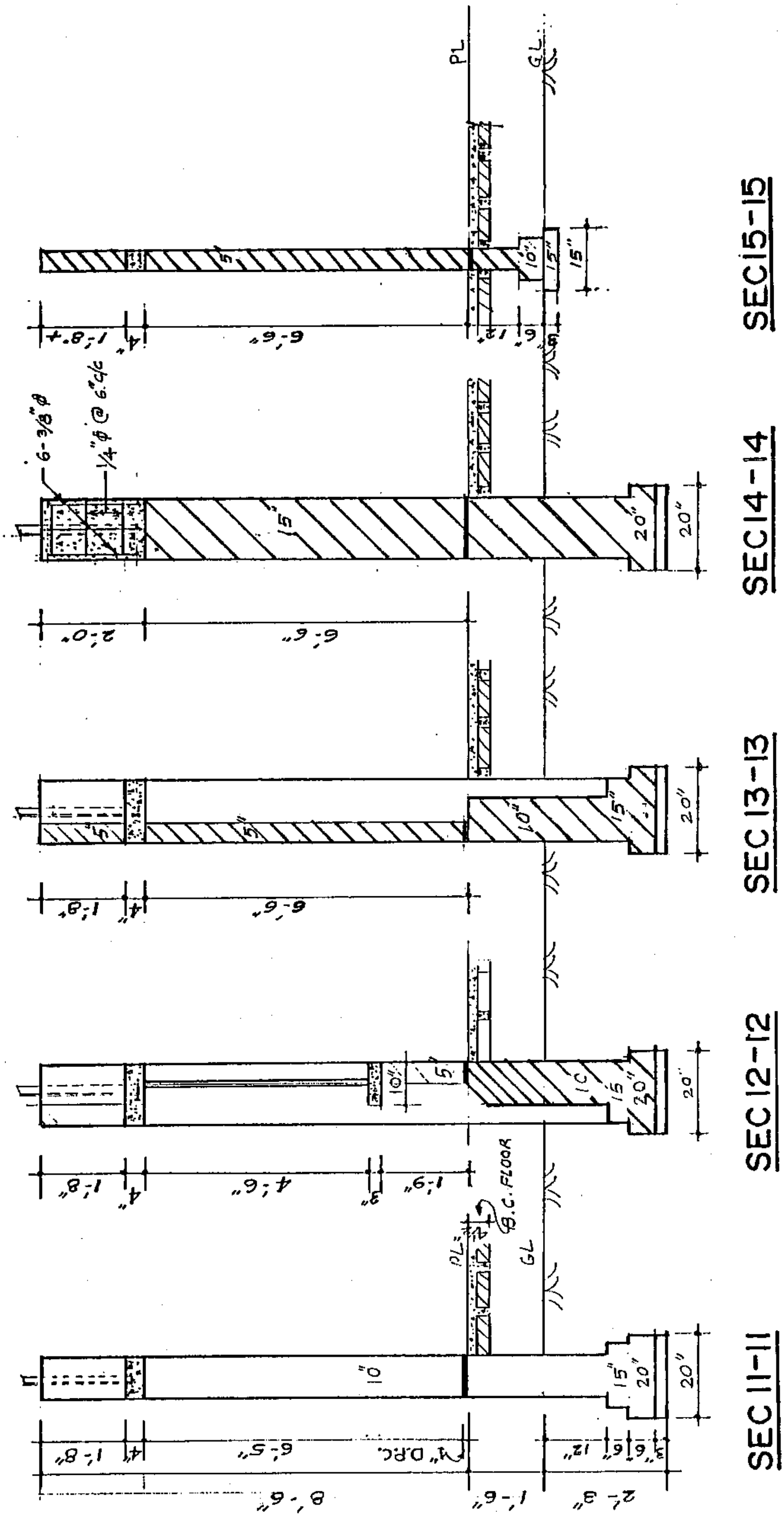
FLOOR PLAN

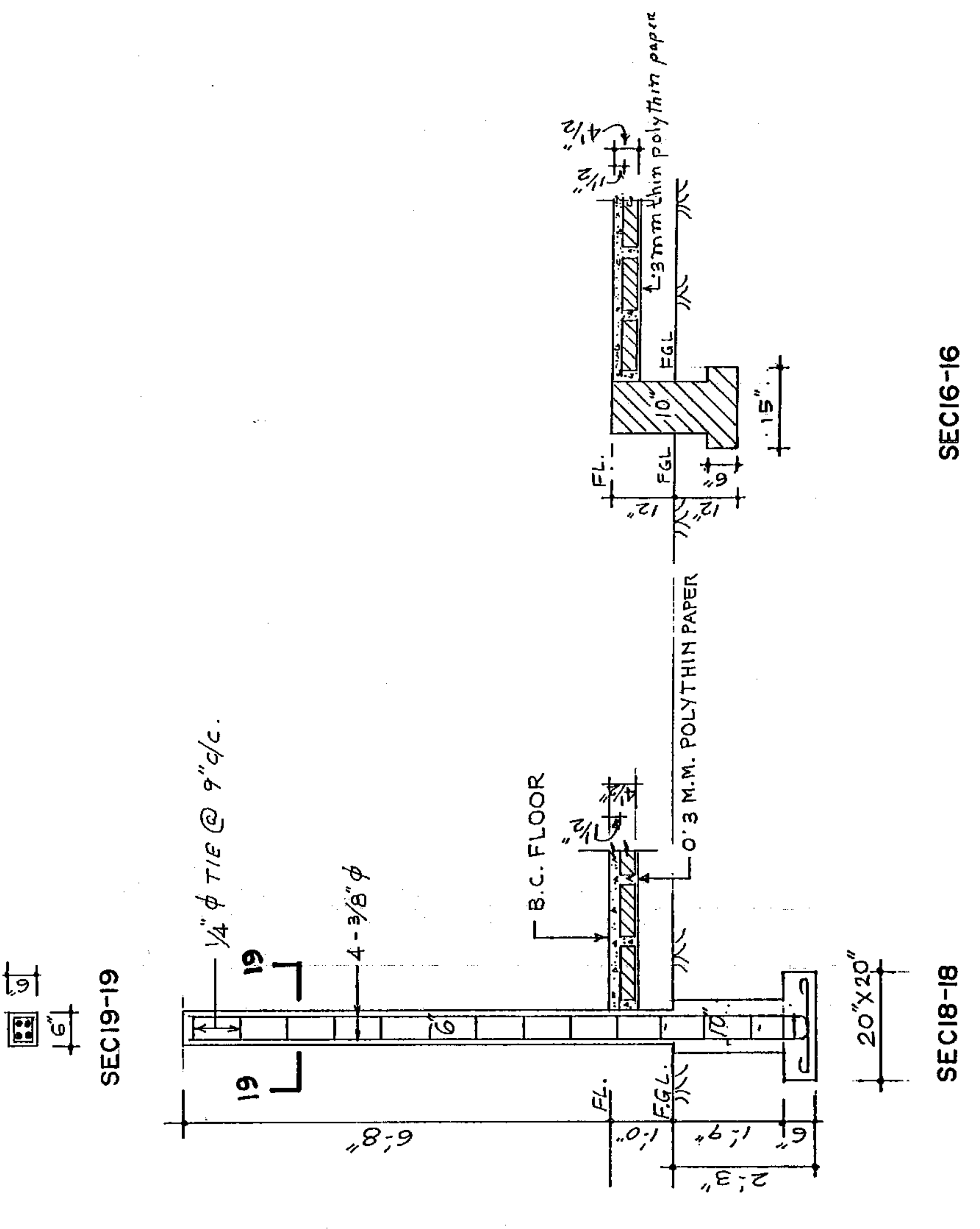
SCALE: 0' 2' 4' 6' 8'



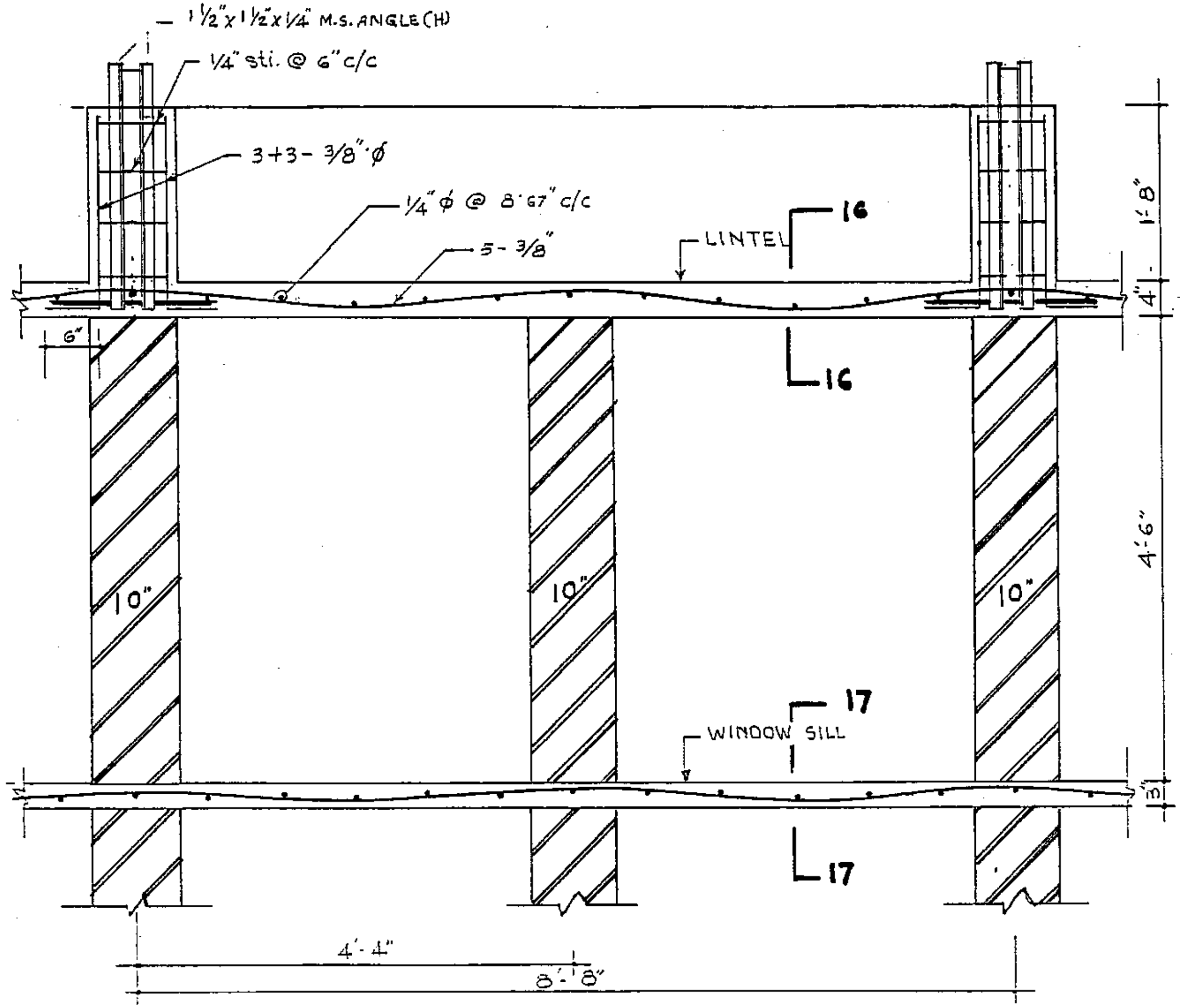
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
4'-6½"
4'-1½"
4'-4"
2½"
2½"
20"
20"
15"
15"
15"
15"
11
11
11
11
12
12
13
13
14
14
15
15
20'-9"
6'-2½"

TRENCH PLAN

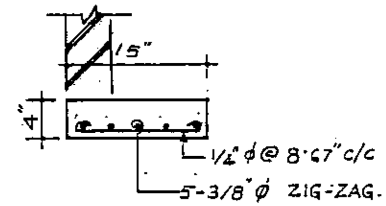

SEC 11-11
SEC 12-12
SEC 13-13
SEC 14-14
SEC 15-15
PL
GL
B.C. FLOOR
4" D.P.C.
6-3/8"φ
1/4"φ @ 6" c/c
8'-6"
1'-6"
2'-3"
1'-8"
6'-5"
6'-6"
4'-6"
1'-9"
2'-0"
1'-8"+
20"
15"
10"
5"



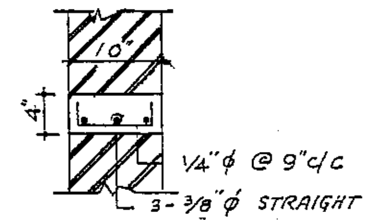
SEC19-19
SEC18-18
SEC16-16
B.C. FLOOR
0'3 M.M. POLYTHIN PAPER
3mm thin polythin paper
1/4" φ TIE @ 9" c/c.
4 - 3/8" φ
20"X20"
F.L.
F.G.L.
FGL
6'-8"
1'-0"
1'-9"
2'-3"
10"
15"
12"



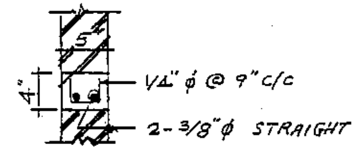
X-SEC. THROUGH LONG WALL



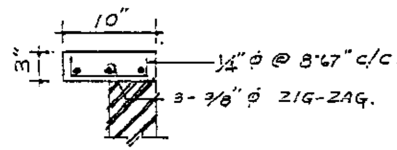
SEC. 16-16



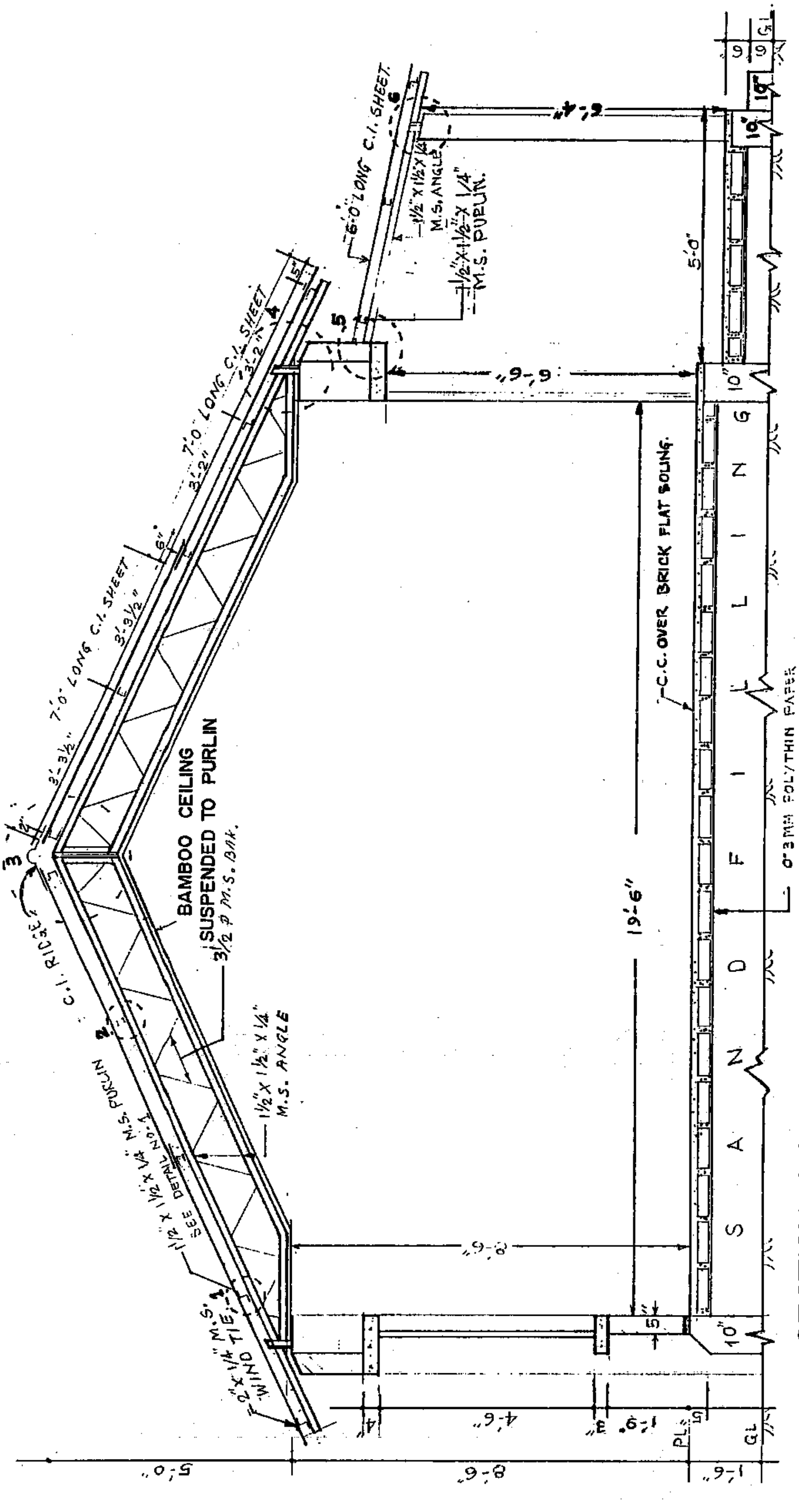
LINTEL AT 10" SOLID WALL



LINTEL AT 5" SOLID WALL

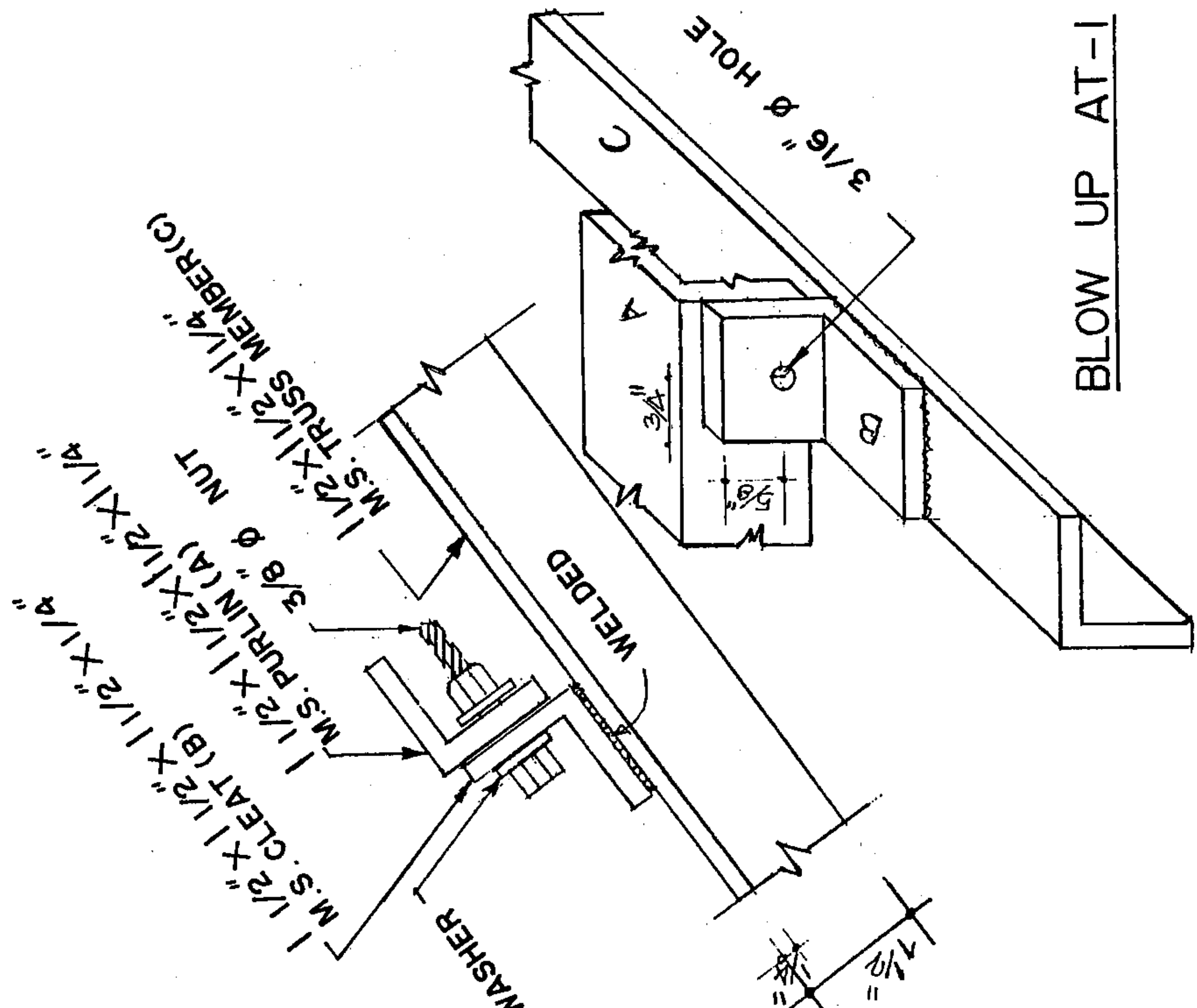


SEC 17-17

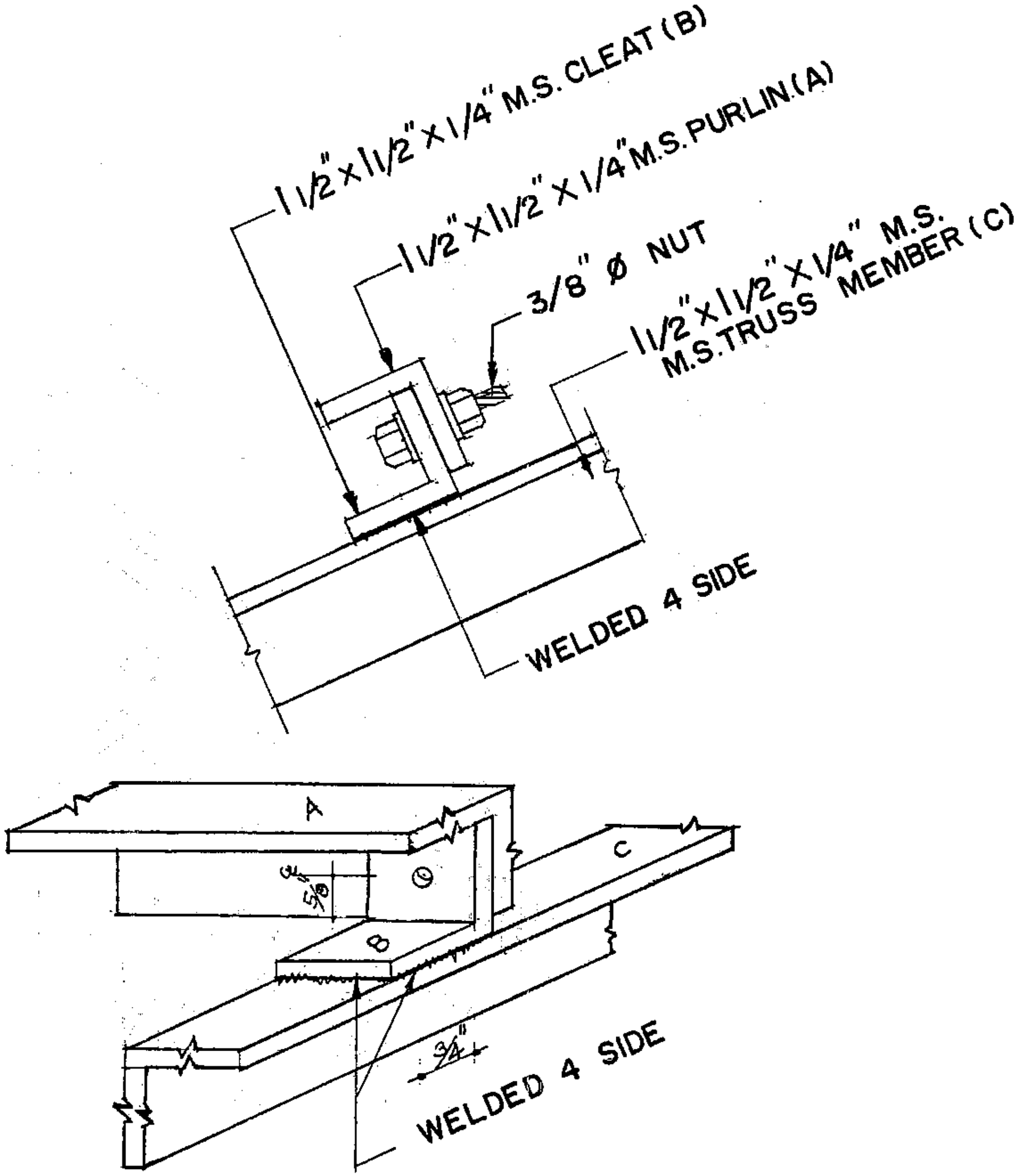


SECTION 1-1

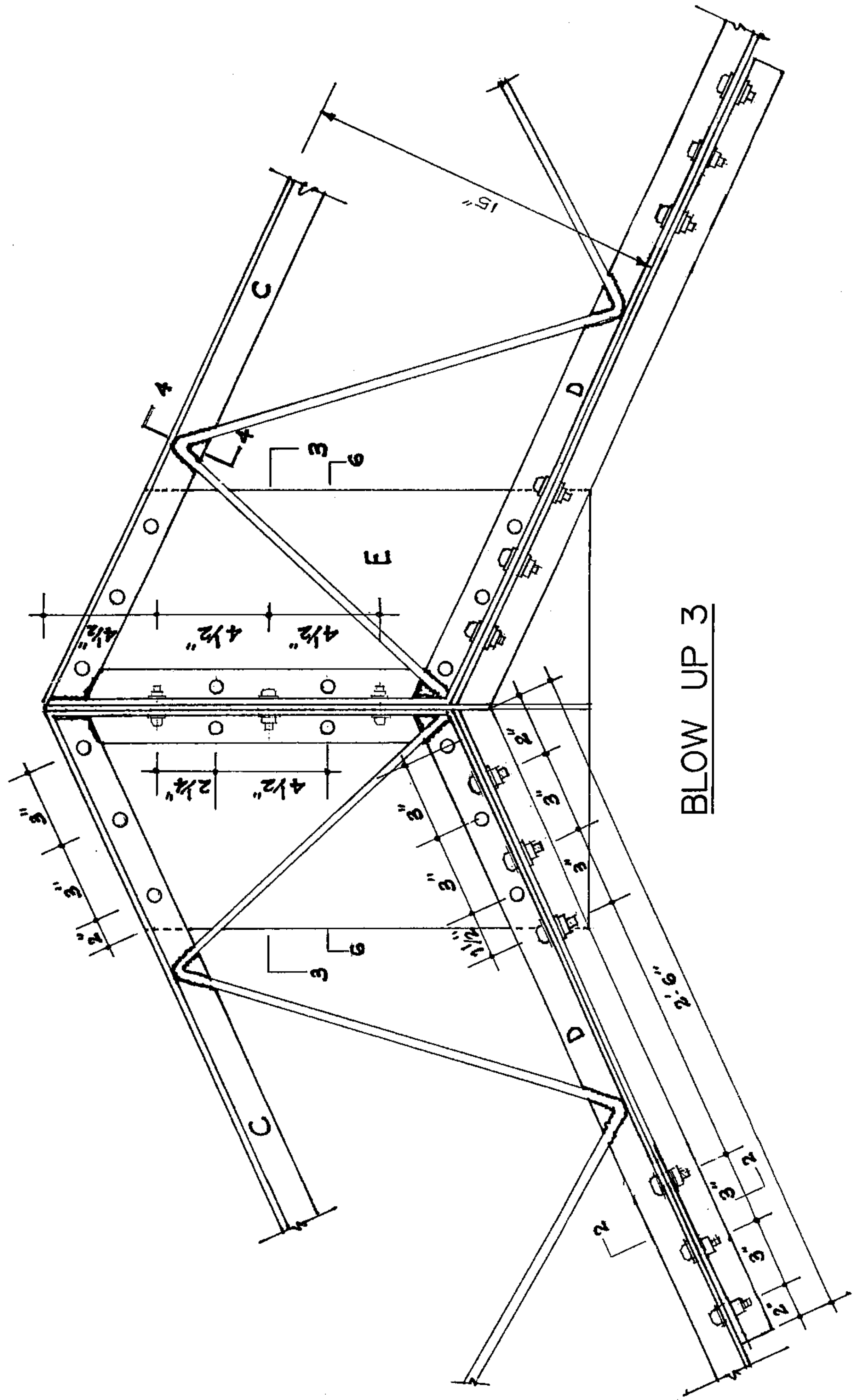
SCALE: 0 1 2 3 4 FEET


M.S. 1 1/2"X1 1/2"X1/4" TRUSS MEMBER(C)
3/16" φ HOLE
C
A
B
3/4"
5/8"
WELDED
3/8" φ NUT
M.S. PURLIN (A) 1 1/2"X1 1/2"X1/4"
M.S. CLEAT (B) 1 1/2"X1 1/2"X1/4"
WASHER
1 1/2"
3/4"

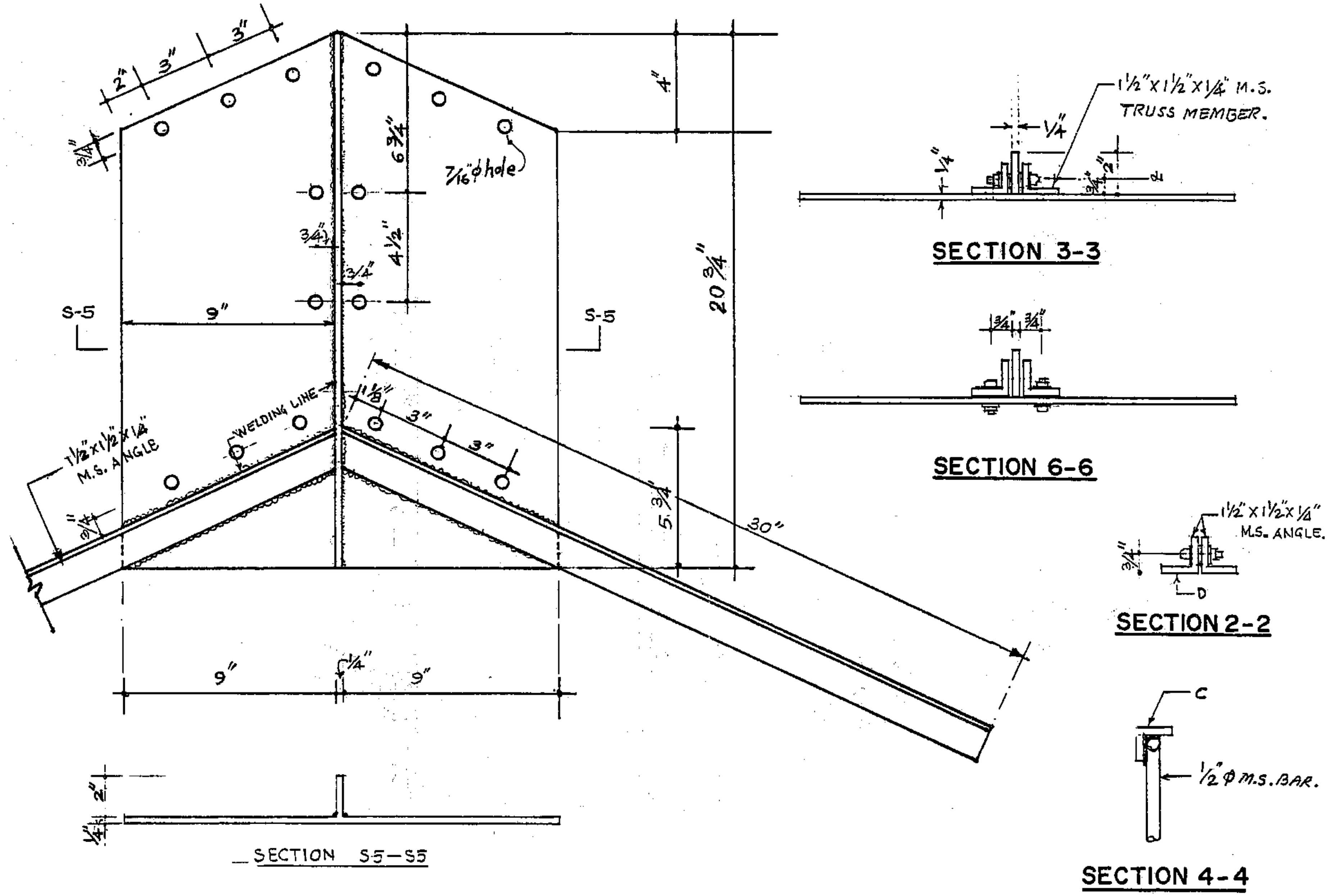
BLOW UP AT-I


1 1/2" x 1 1/2" x 1/4" M.S. CLEAT (B)
1 1/2" x 1 1/2" x 1/4" M.S. PURLIN (A)
3/8" Ø NUT
1 1/2" x 1 1/2" x 1/4" M.S. M.S. TRUSS MEMBER (C)
WELDED 4 SIDE
A
C
B
3/4"
WELDED 4 SIDE

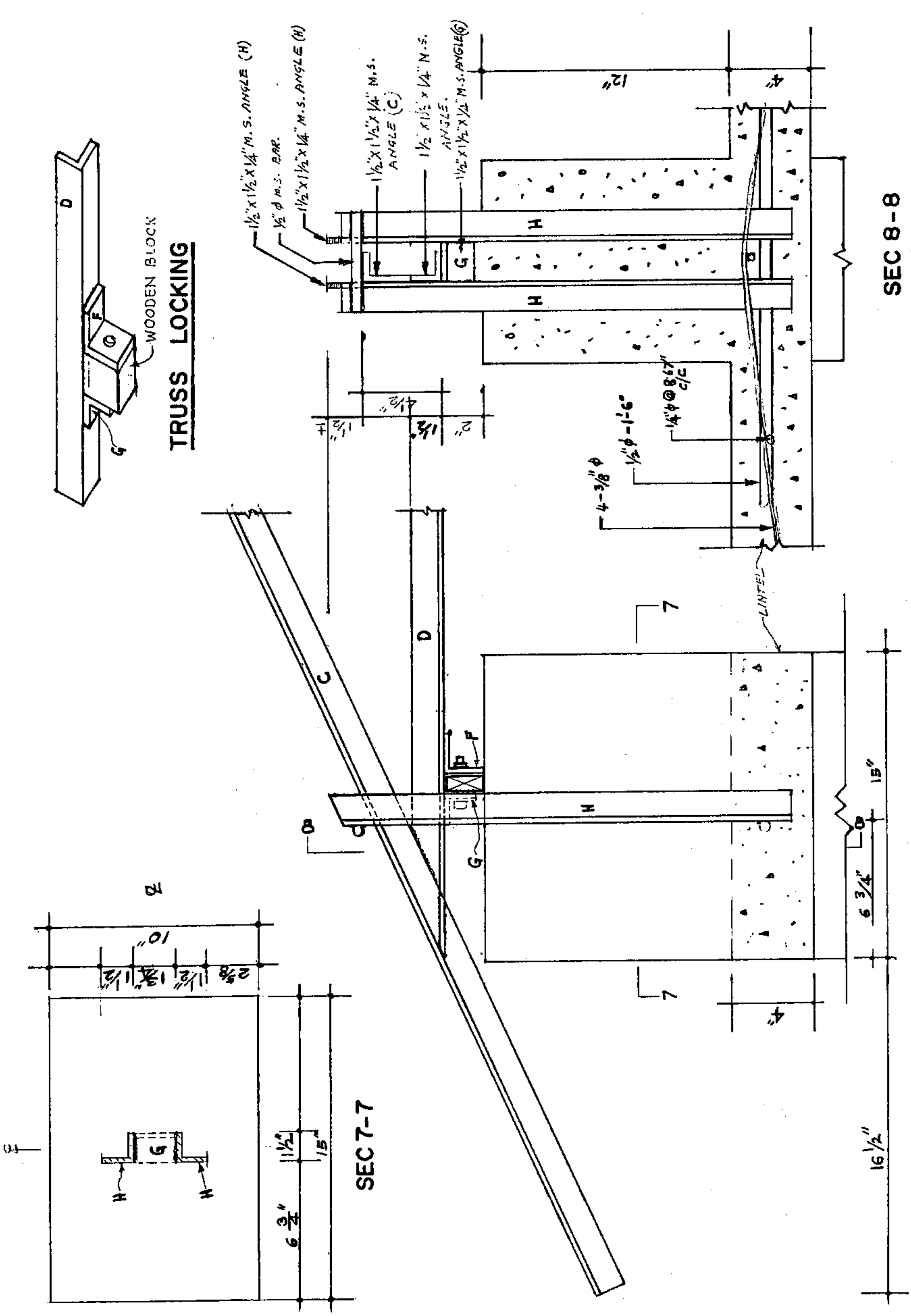
BLOW UP 2

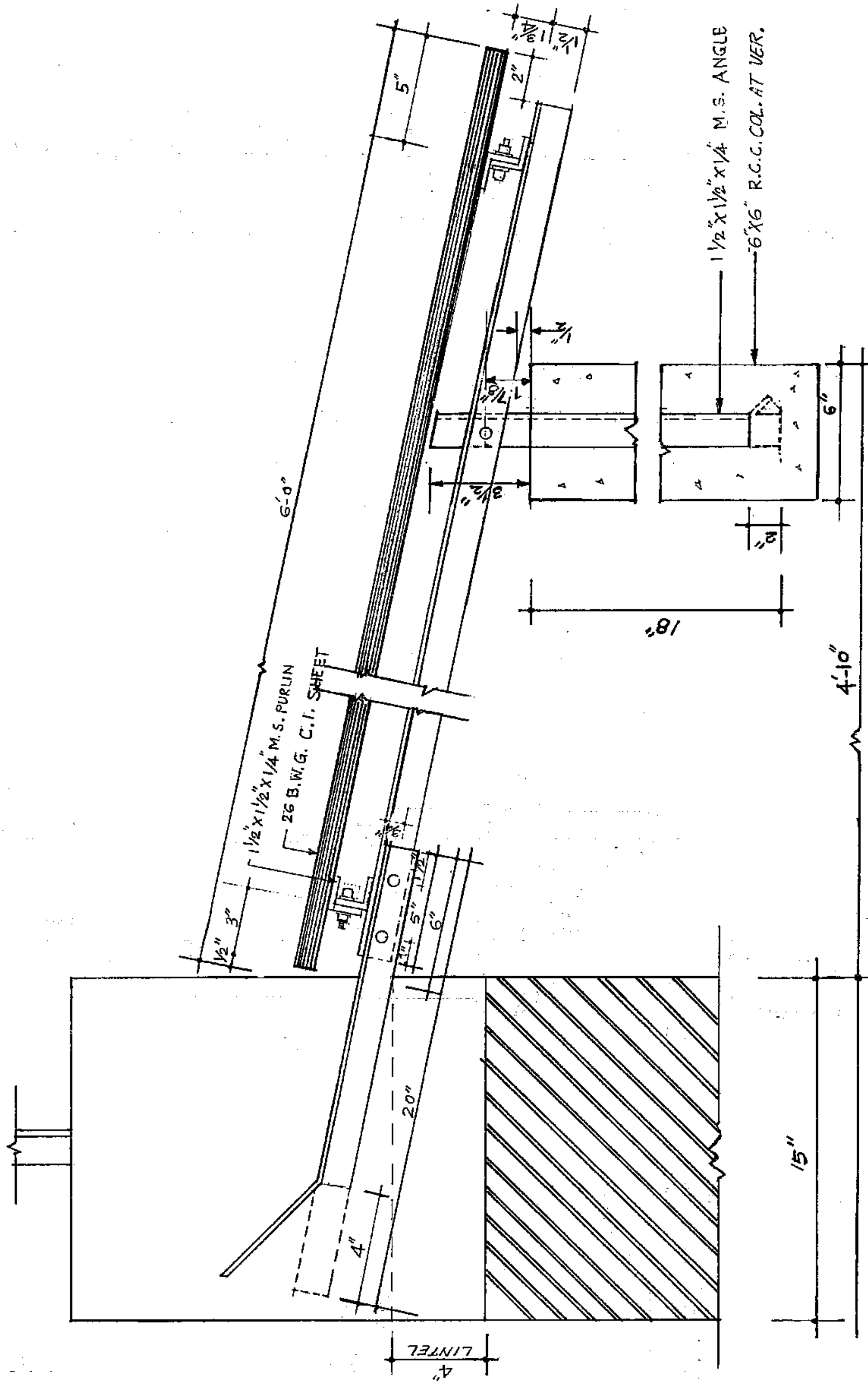


BLOW UP 3

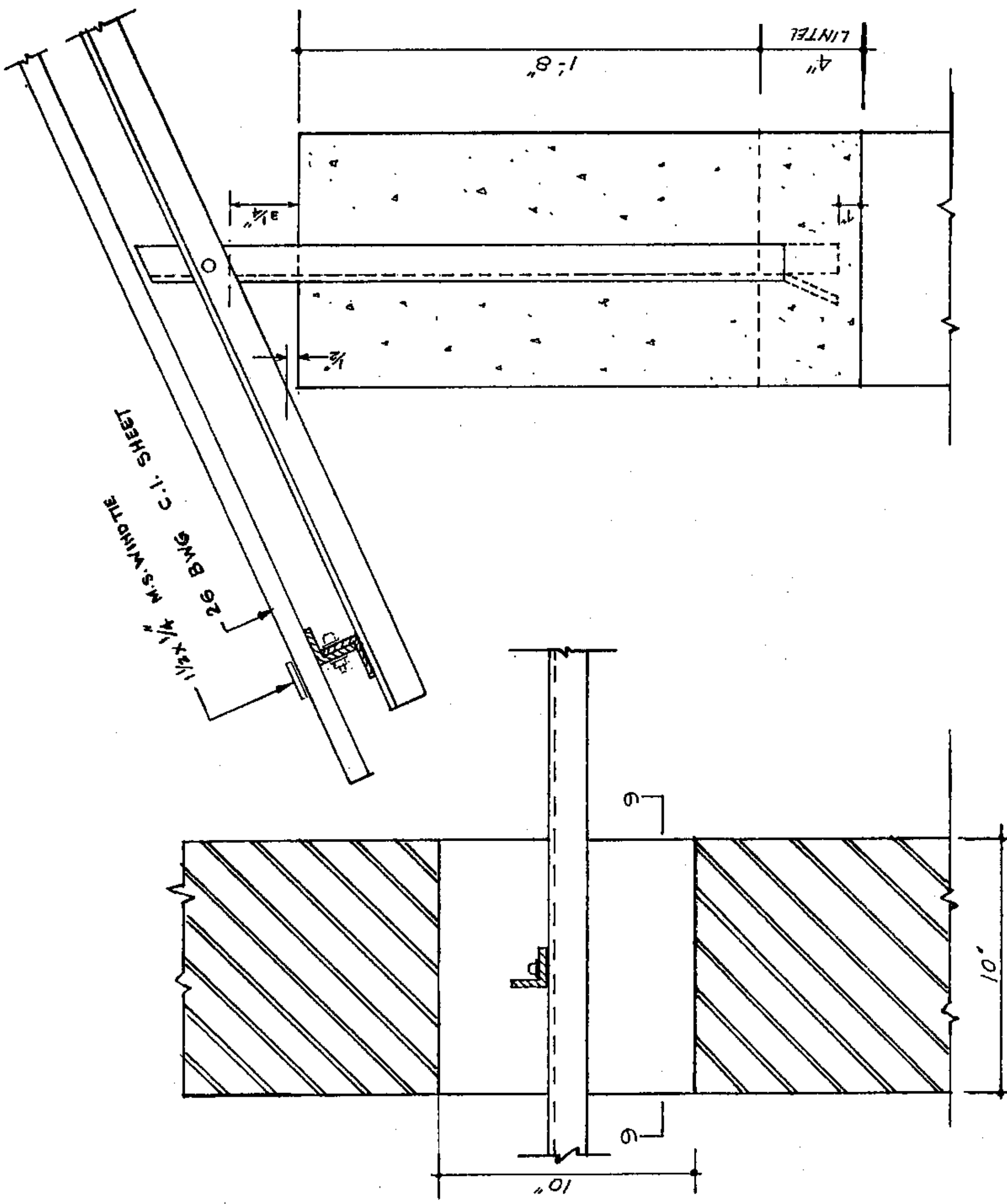


DETAILS OF CROW TRAP(E)


TRUSS LOCKING
WOODEN BLOCK
1½"x1½"x¼" M.S. ANGLE (H)
½" φ M.S. BAR
1½"x1½"x¼" M.S. ANGLE (C)
1½"x1½"x¼" M.S. ANGLE (G)
4-3/8" φ
½" φ -1'-6"
¼" φ @ 8.67" c/c
LINTEL
SEC 8-8
SEC 7-7
BLOW UP 4
16½"
15"
6 ¾"
12"
10"
4"

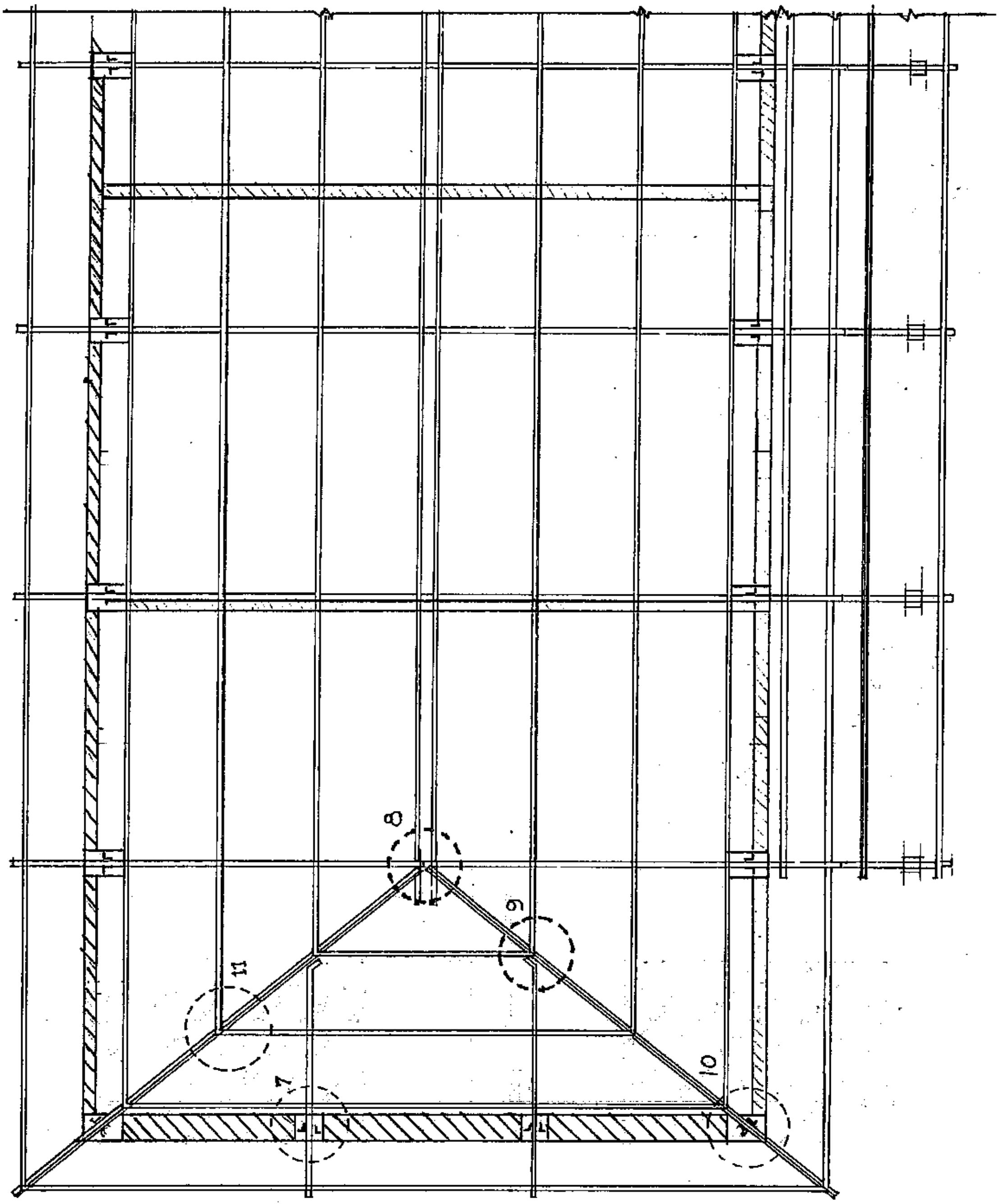

1 1/2"x1 1/2"x1/4" M.S. ANGLE
6"x6" R.C.C. COL. AT VER.
1 1/2"x1 1/2"x1/4" M.S. PURLIN
26 B.W.G. C.I. SHEET
LINTEL
6'-0"
4'-10"
18"
15"
20"
5"
6"
2"
3"
1/2"
4"
3 1/2"

BLOW UP 5 & 6

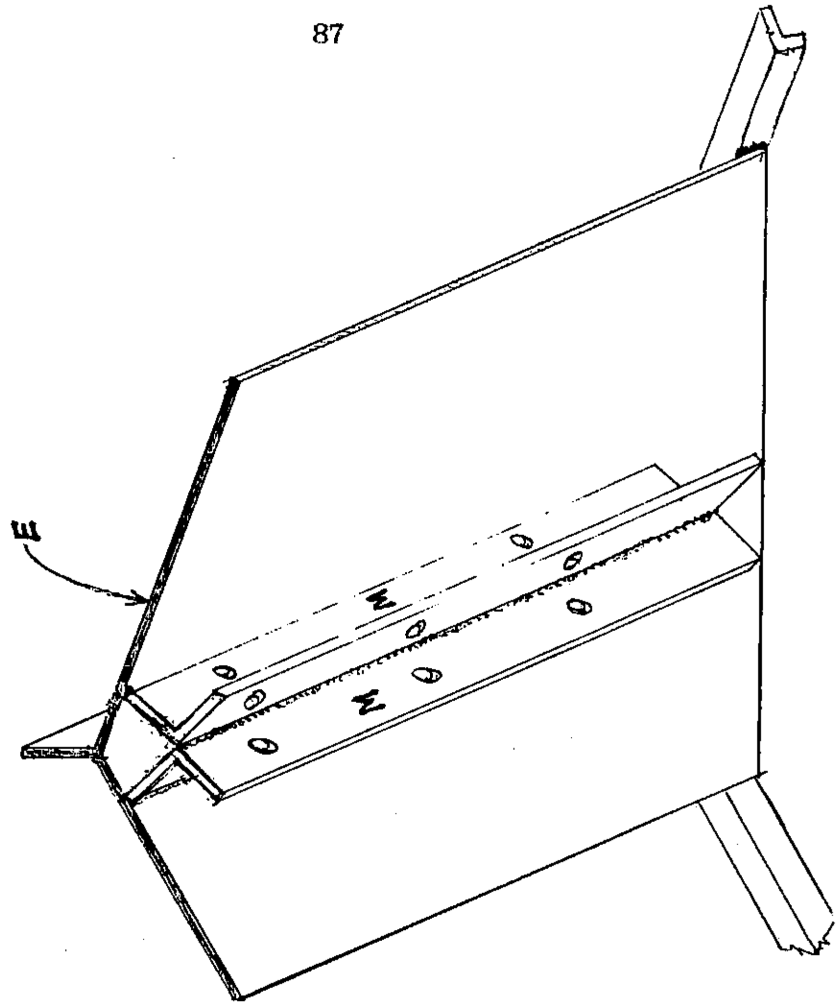


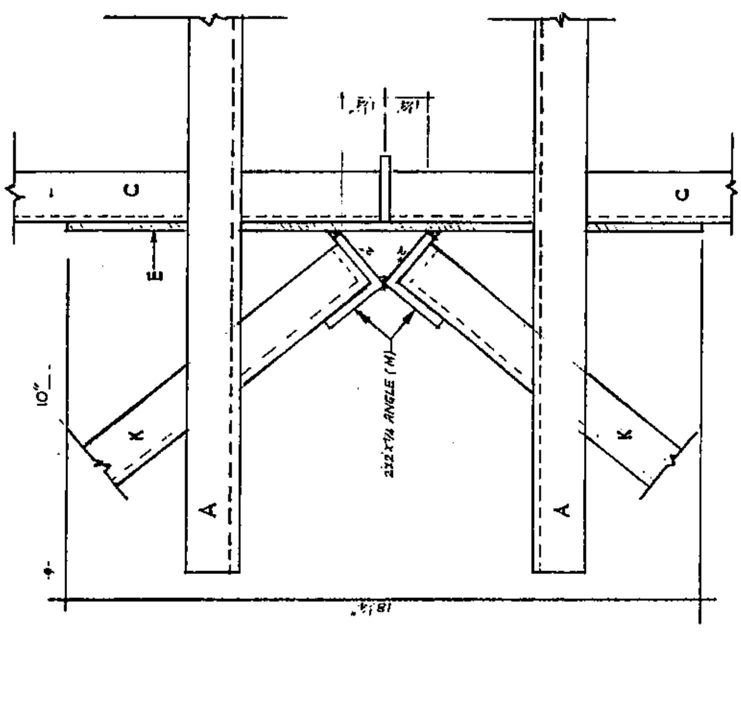
SEC 9-9

BLOW UP 7

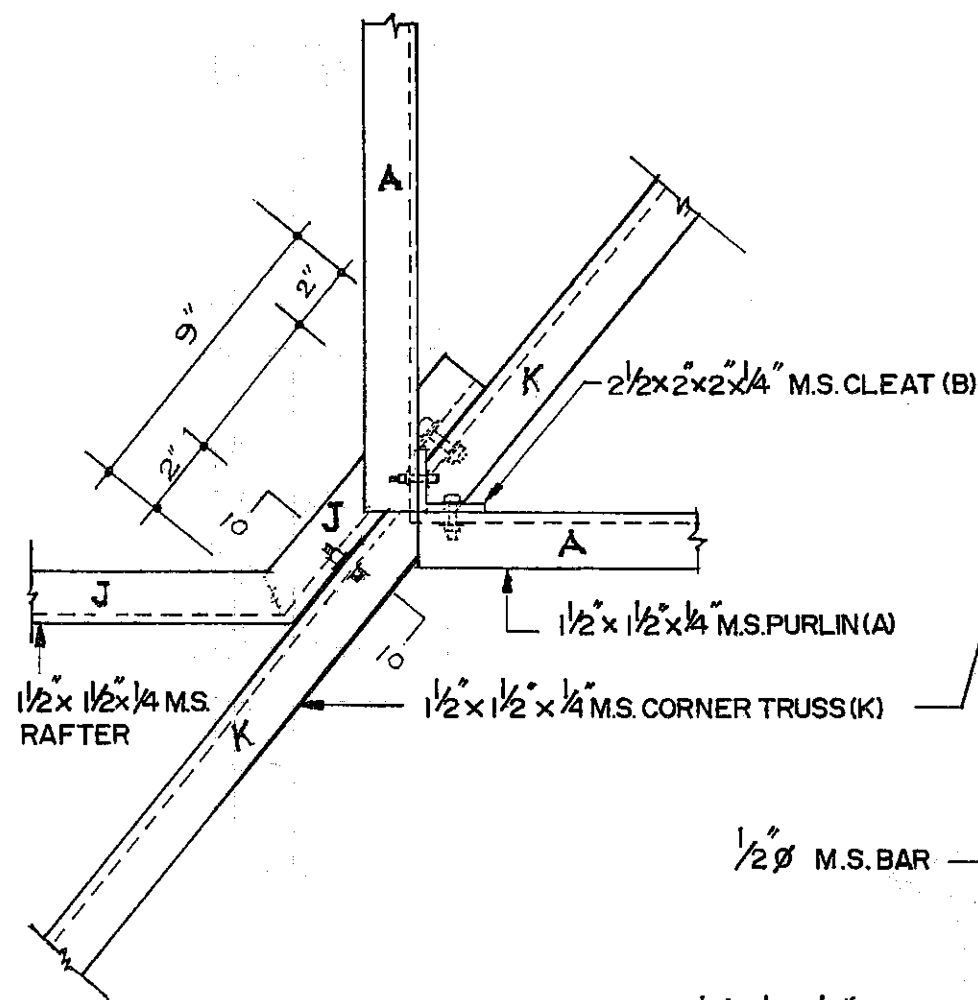


TOP VIEW OF ROOF TRUSS

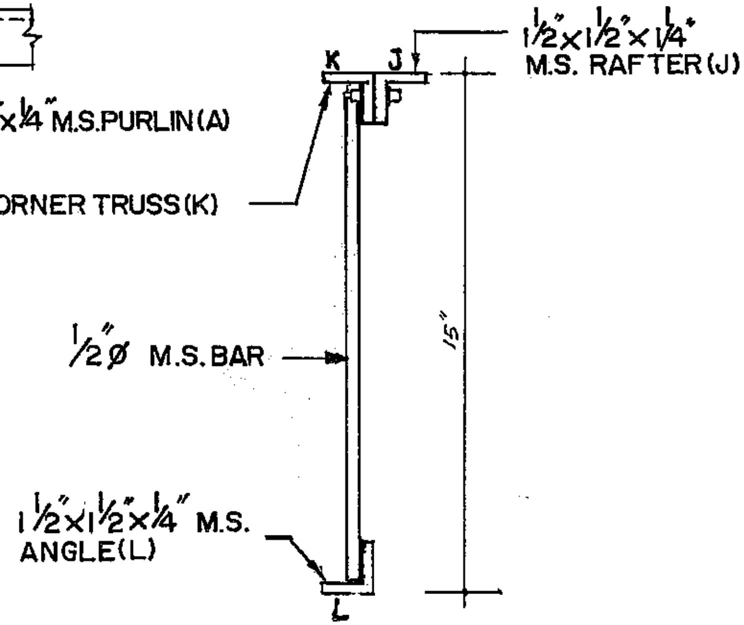




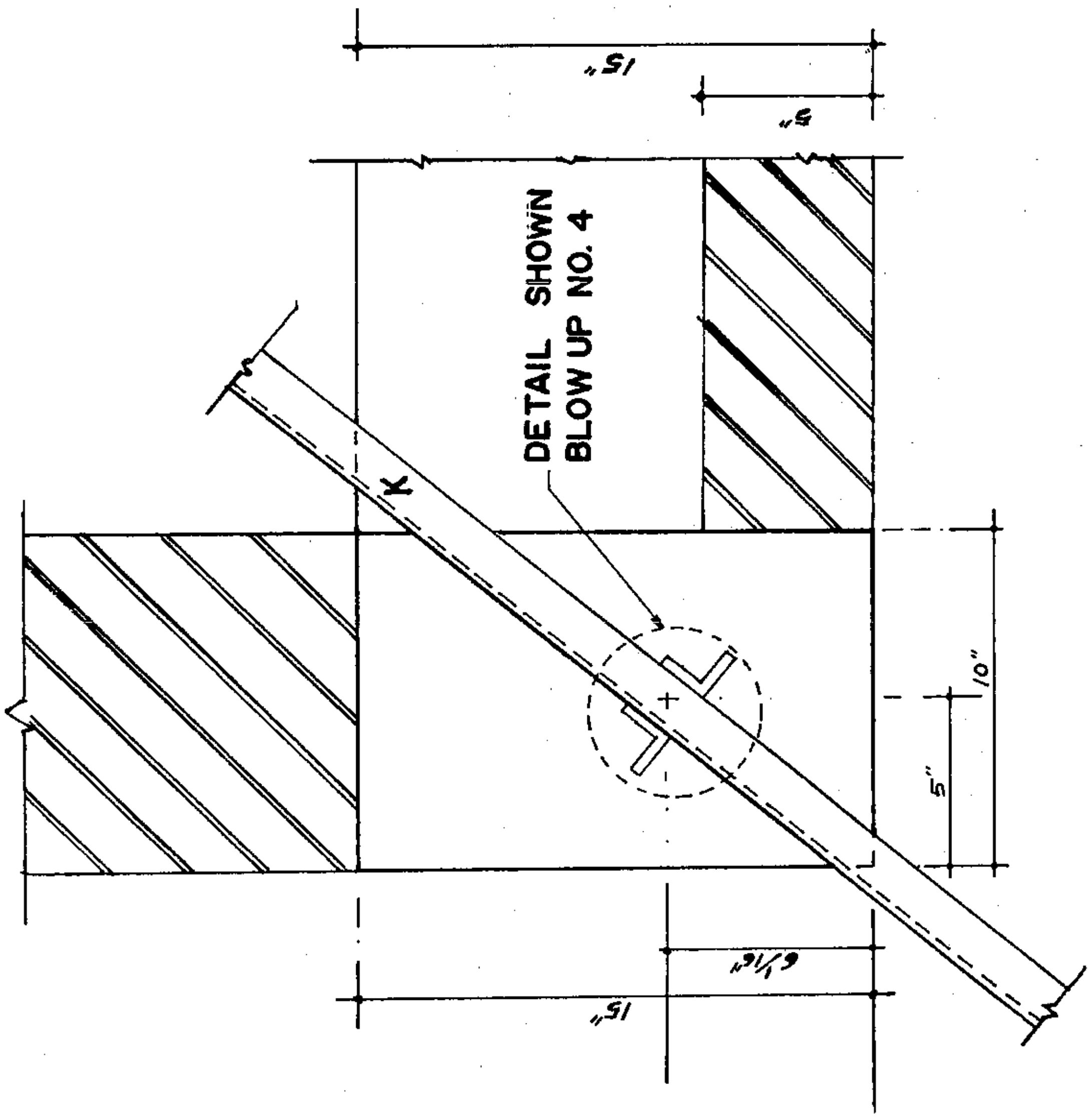
BLOW UP 8



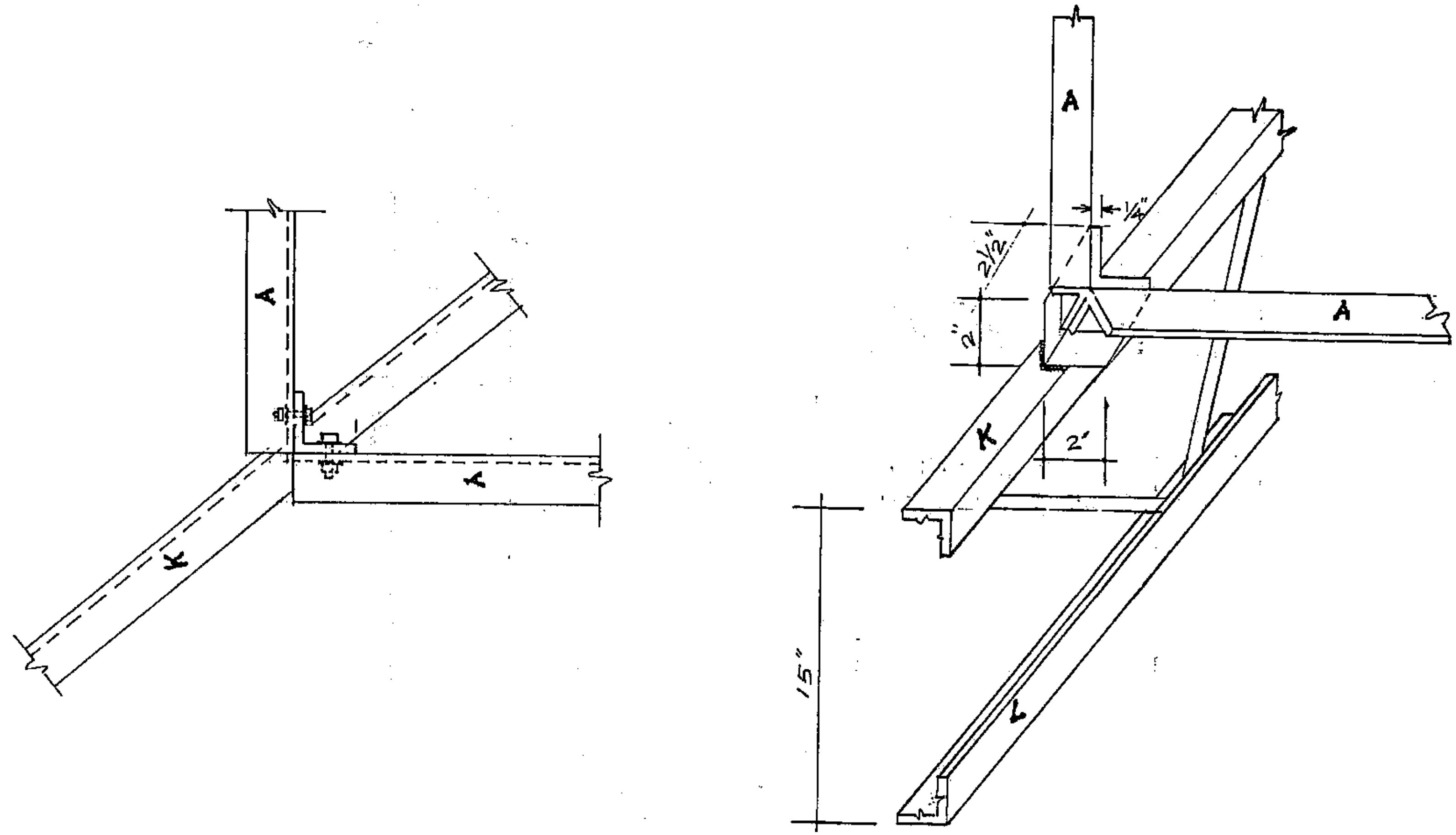
BLOW UP 9



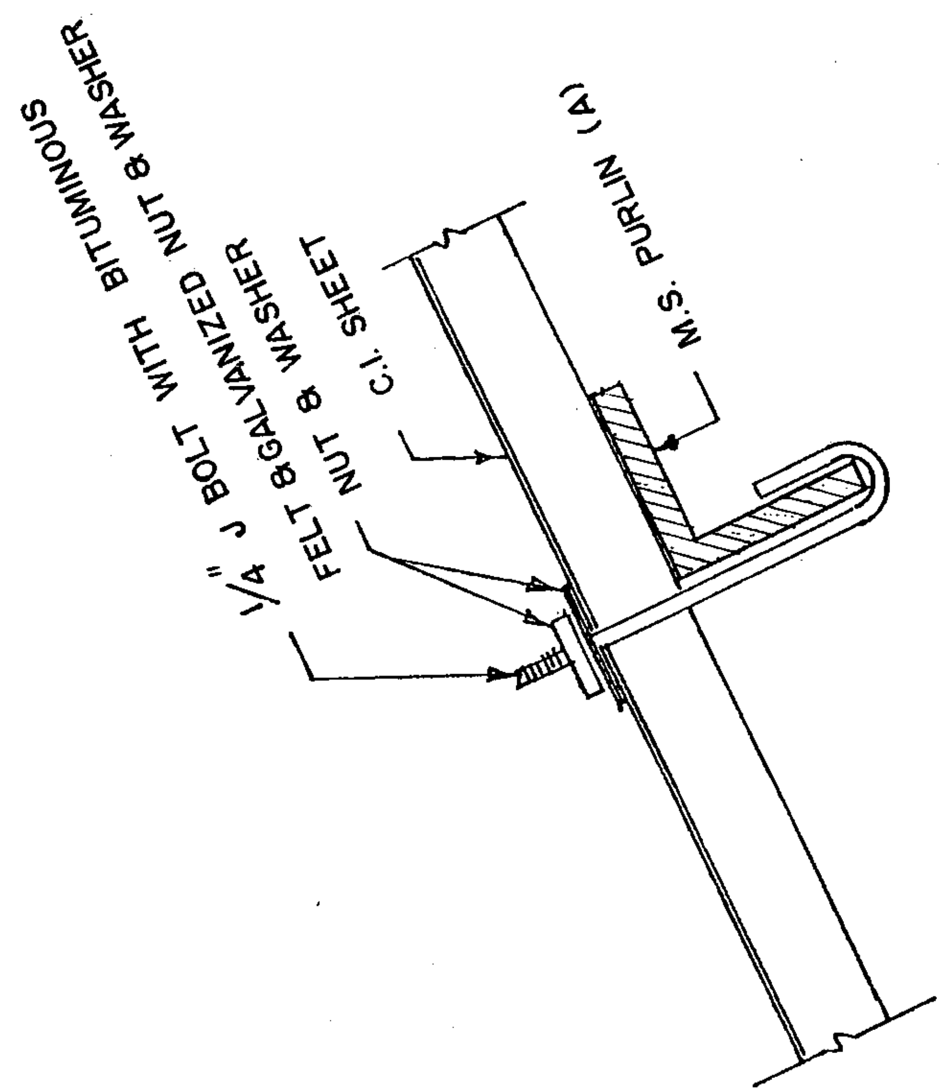
SEC 10-10



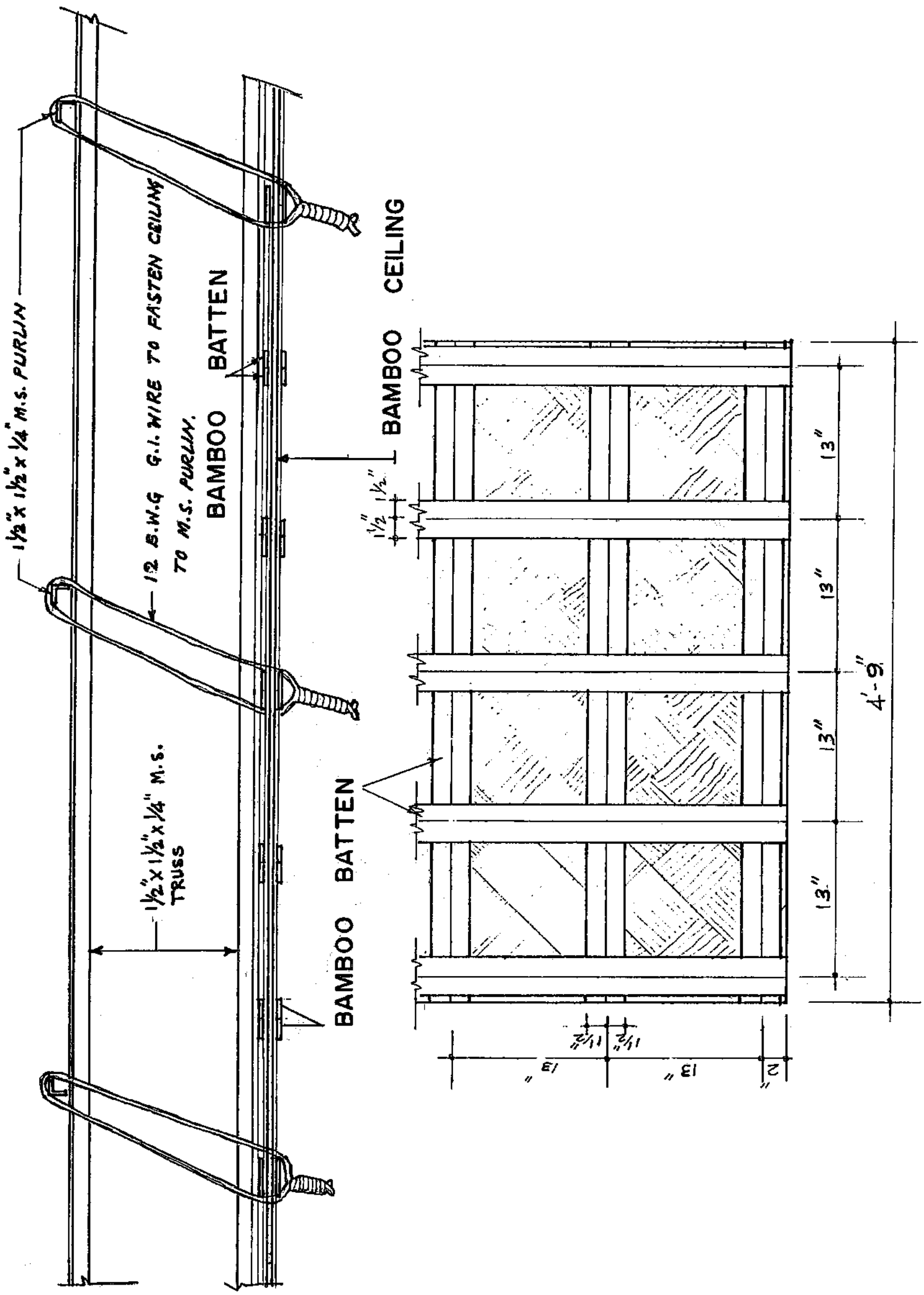
BLOW UP 10



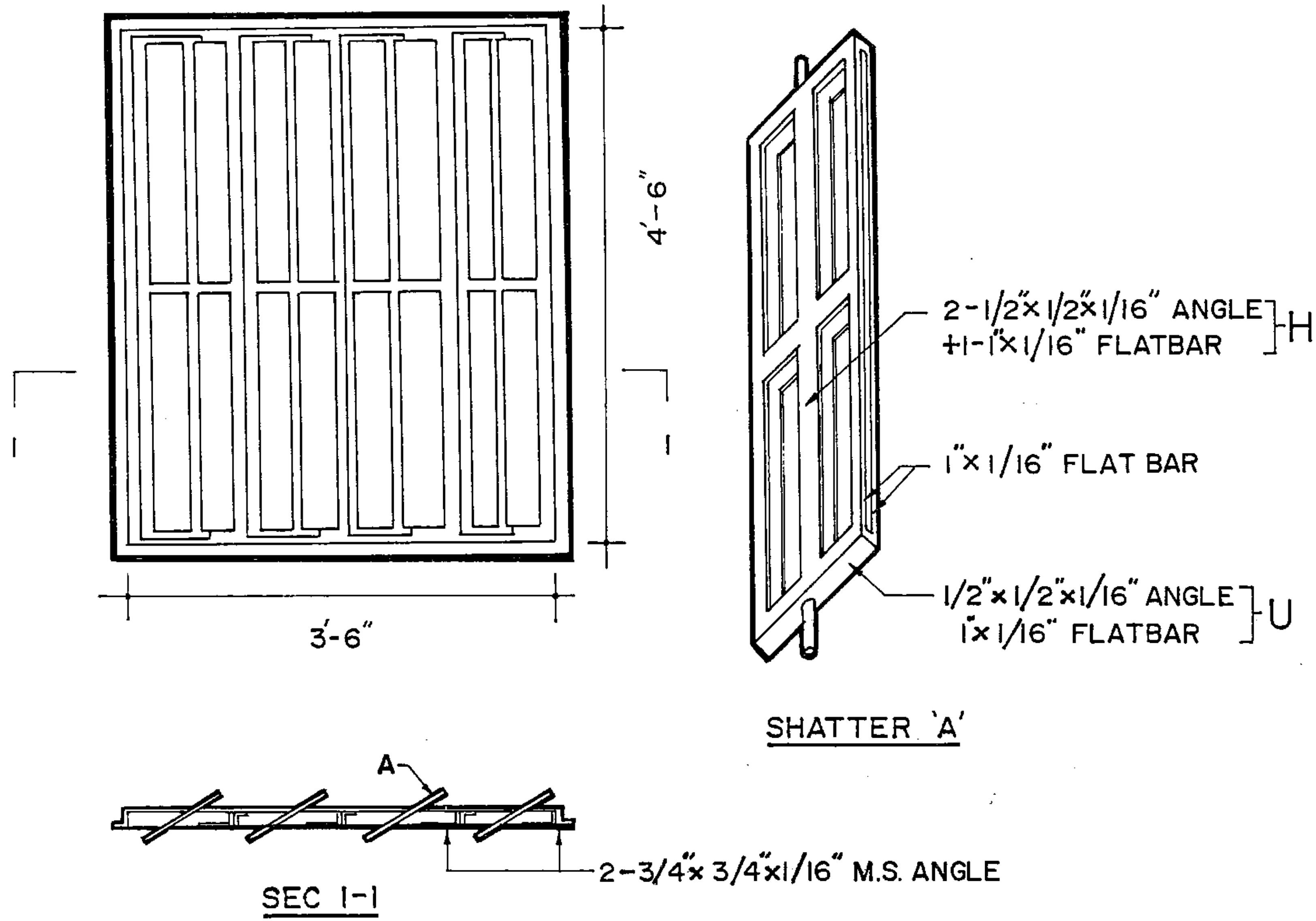
BLOW UP II



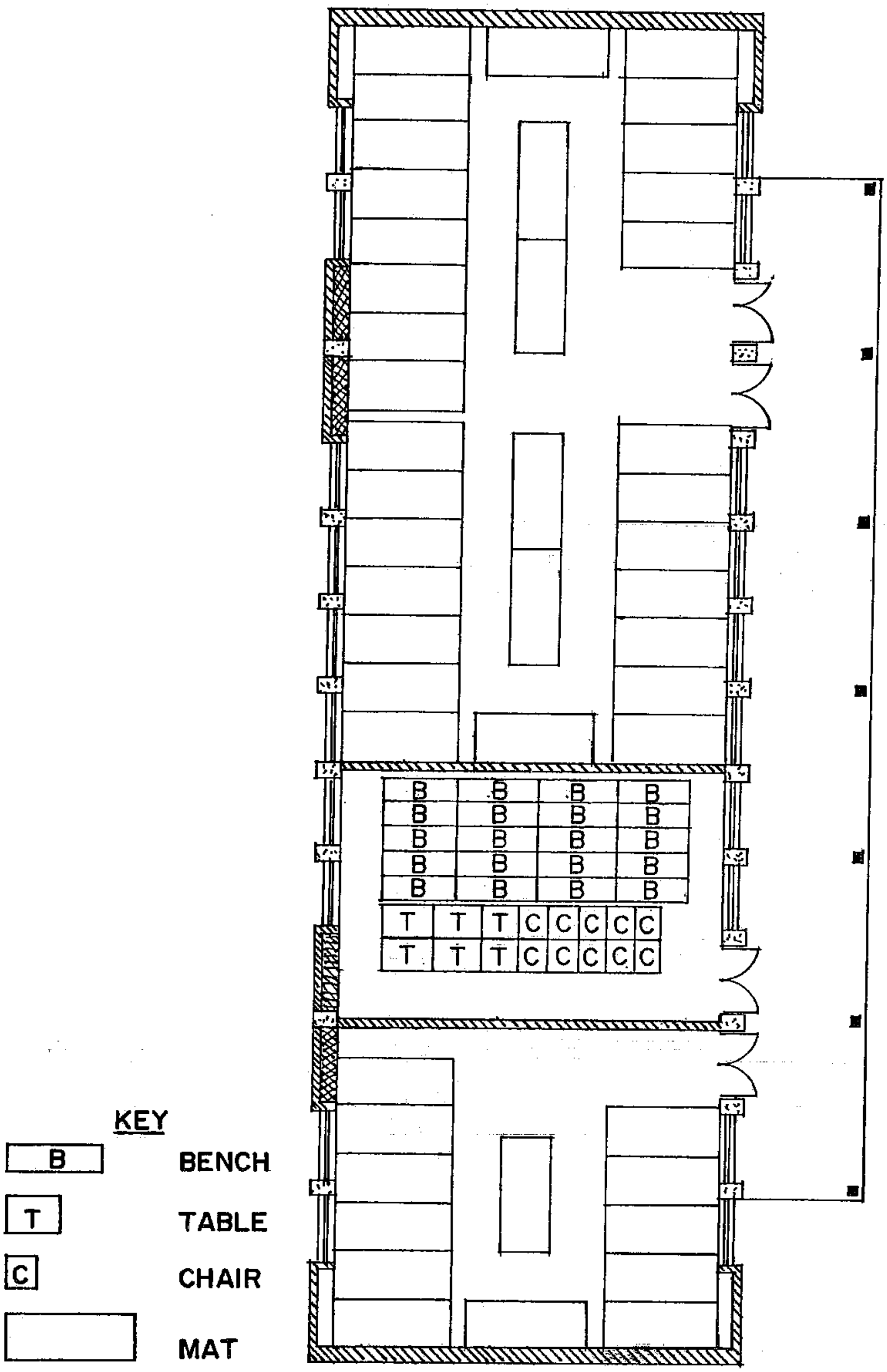
1/4" J BOLT WITH BITUMINOUS
FELT & GALVANIZED NUT & WASHER
NUT & WASHER
C.I. SHEET
M.S. PURLIN (A)



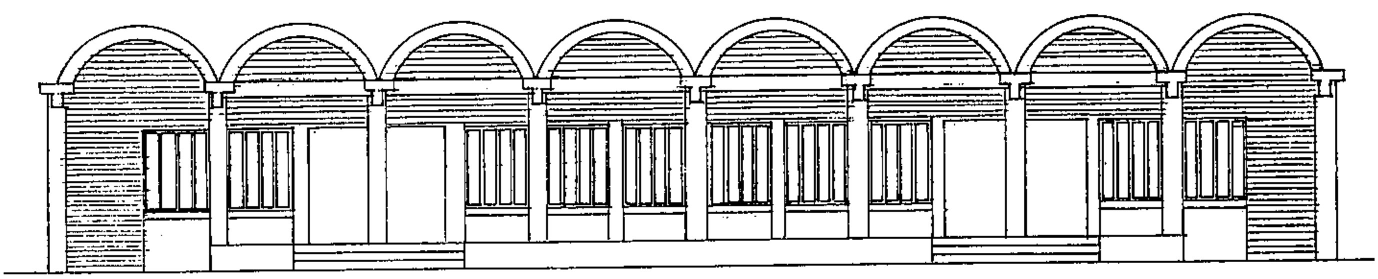
DETAILS OF CEILING



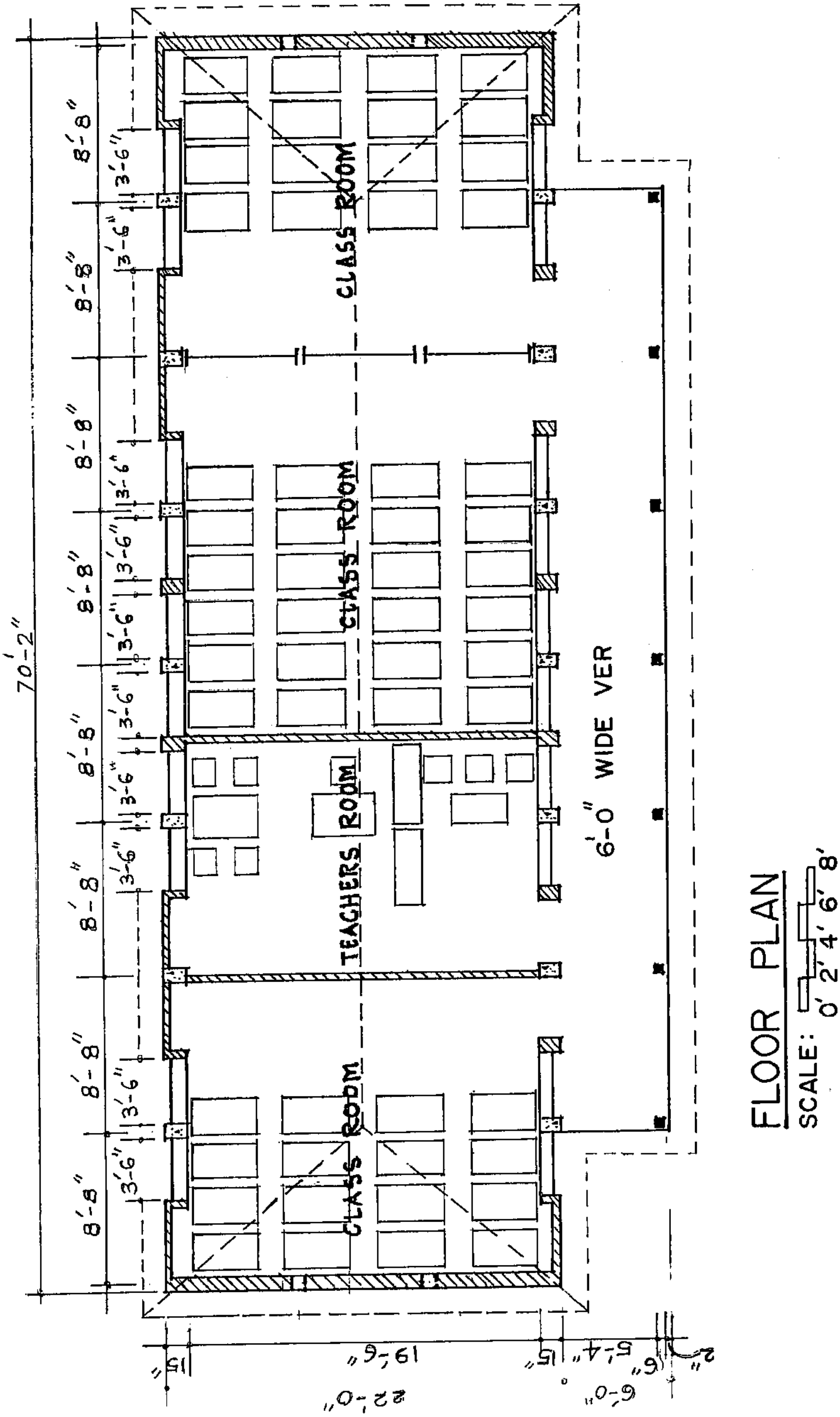
PIVOTED WINDOW

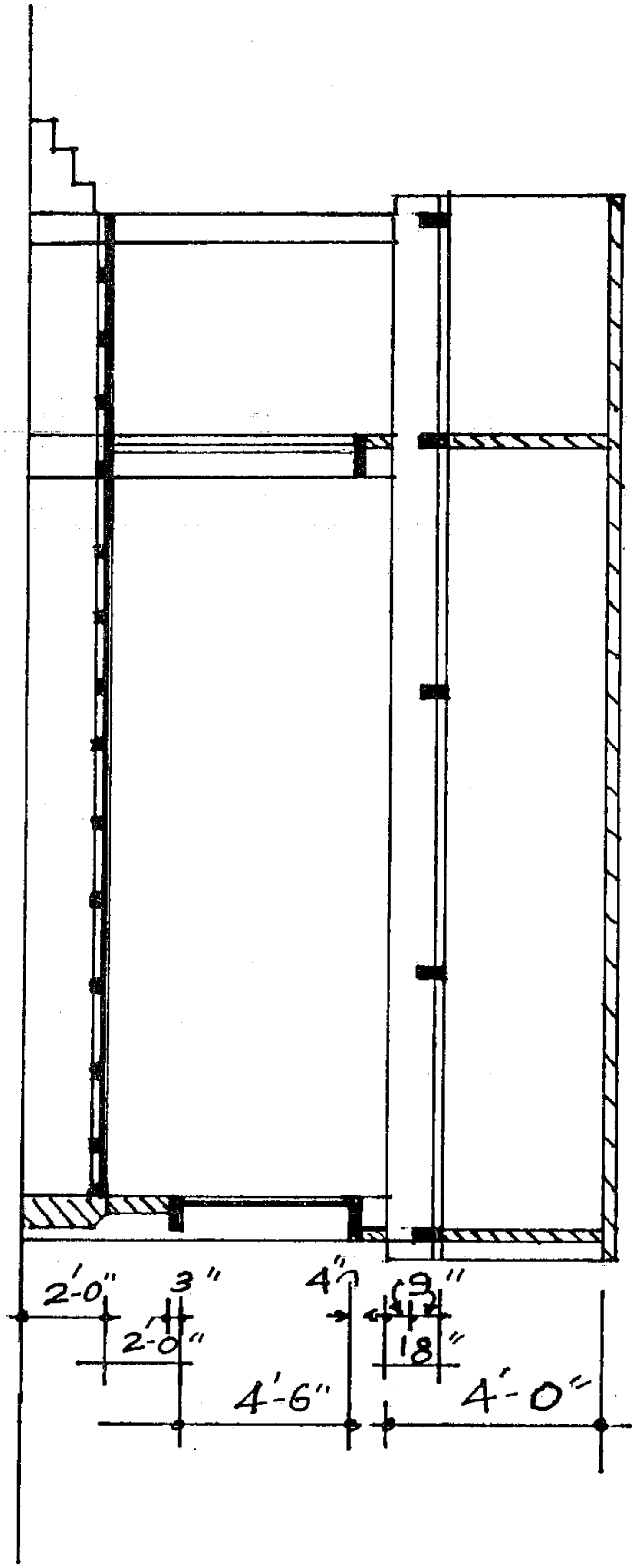

B
T
C
KEY
B BENCH
T TABLE
C CHAIR
MAT

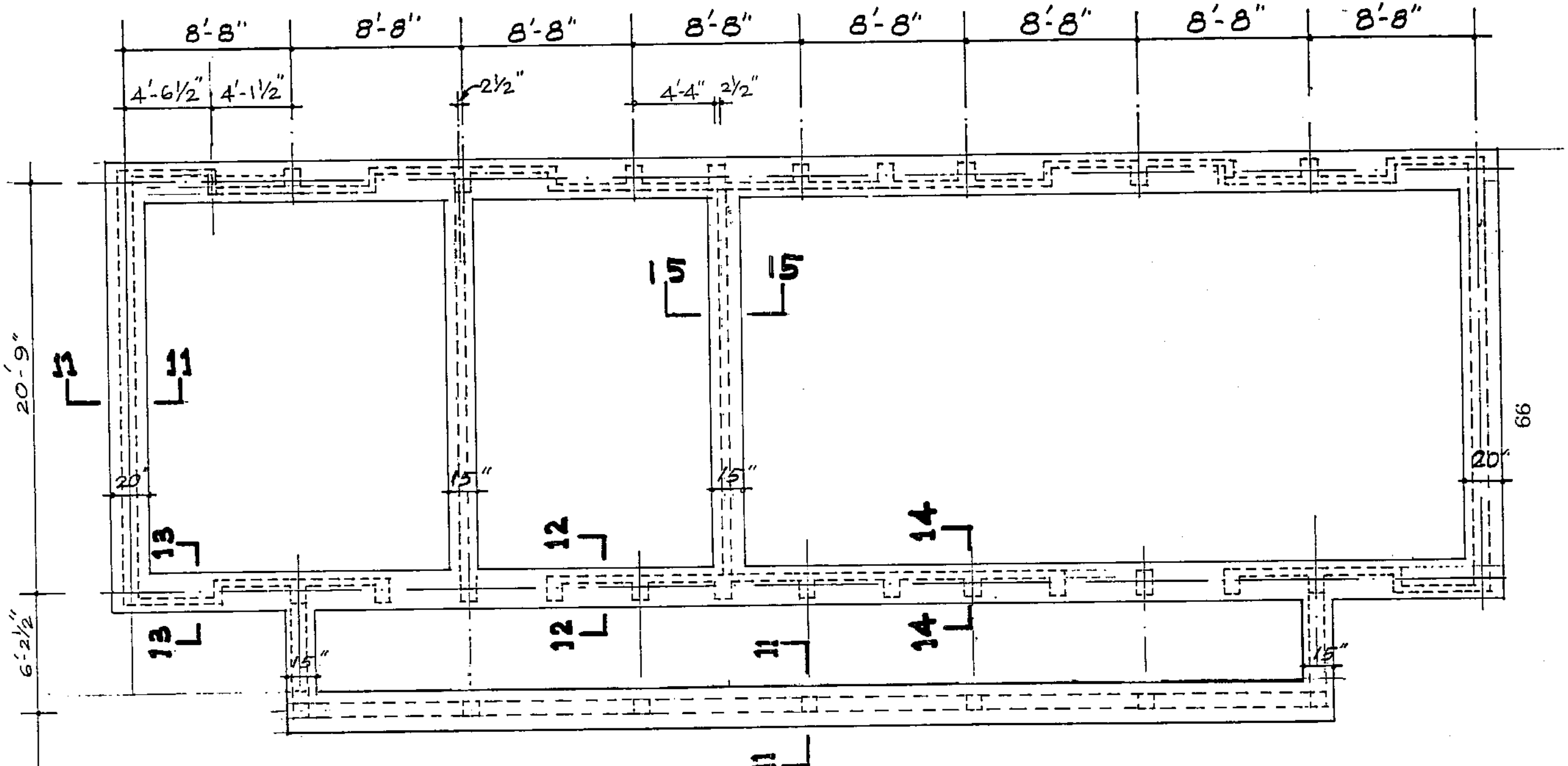
Annex 3. Type B. School: Detailed drawings



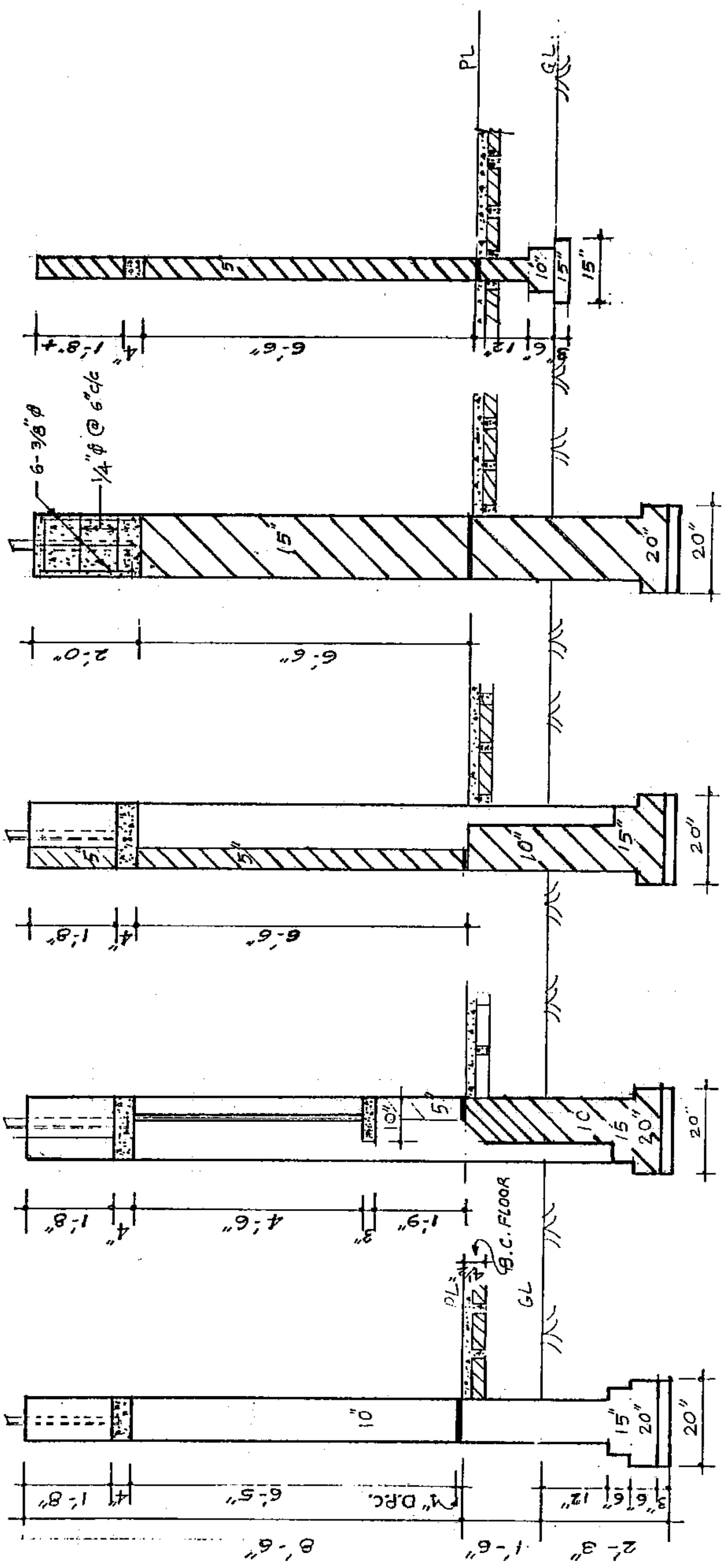
FRONT ELEVATION


70'-2"
8'-8"
3'-6"
CLASS ROOM
TEACHERS ROOM
6'-0" WIDE VER
22'-0"
19'-6"
15"
5'-4"
6"
6'-0"
2"
FLOOR PLAN
SCALE: 0' 2' 4' 6' 8'

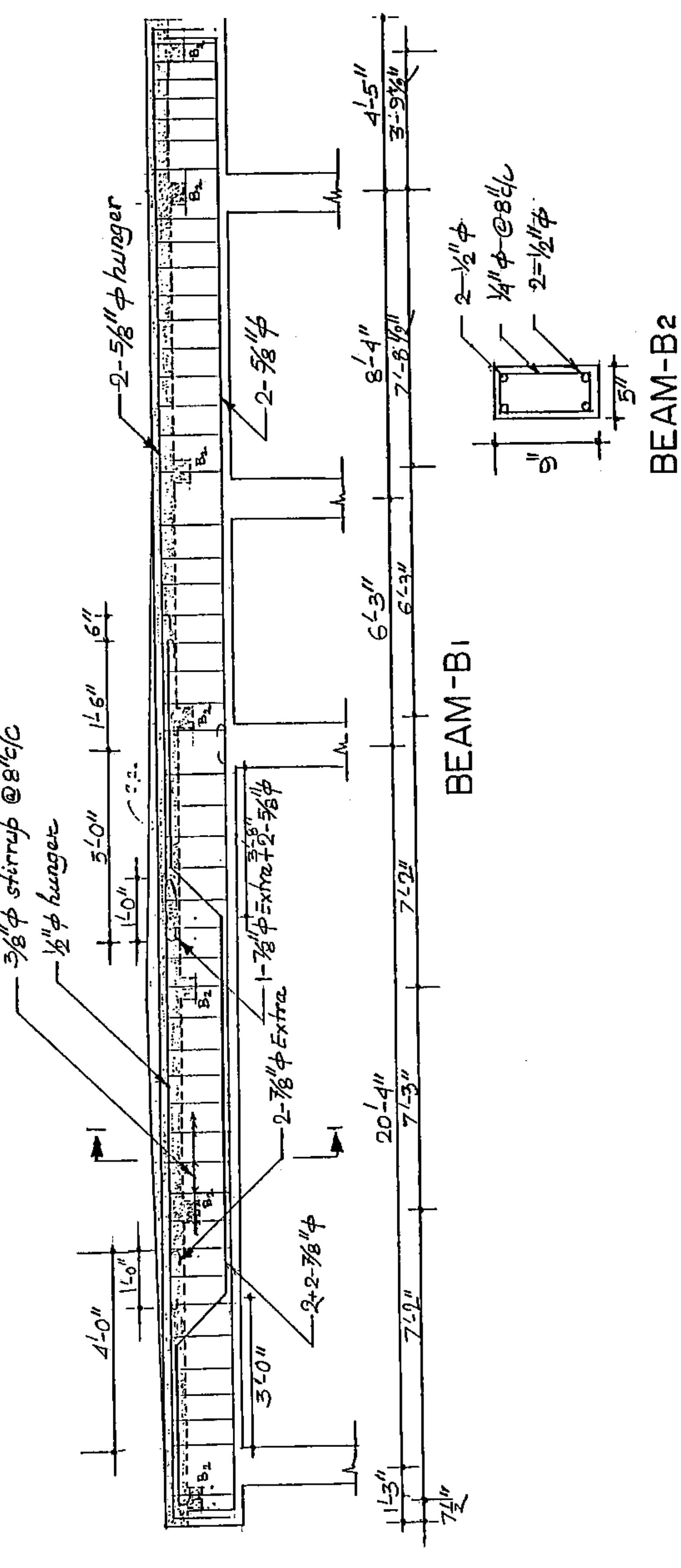

2'-0"
3"
4"
9"
2'-0"
18"
4'-6"
4'-0"

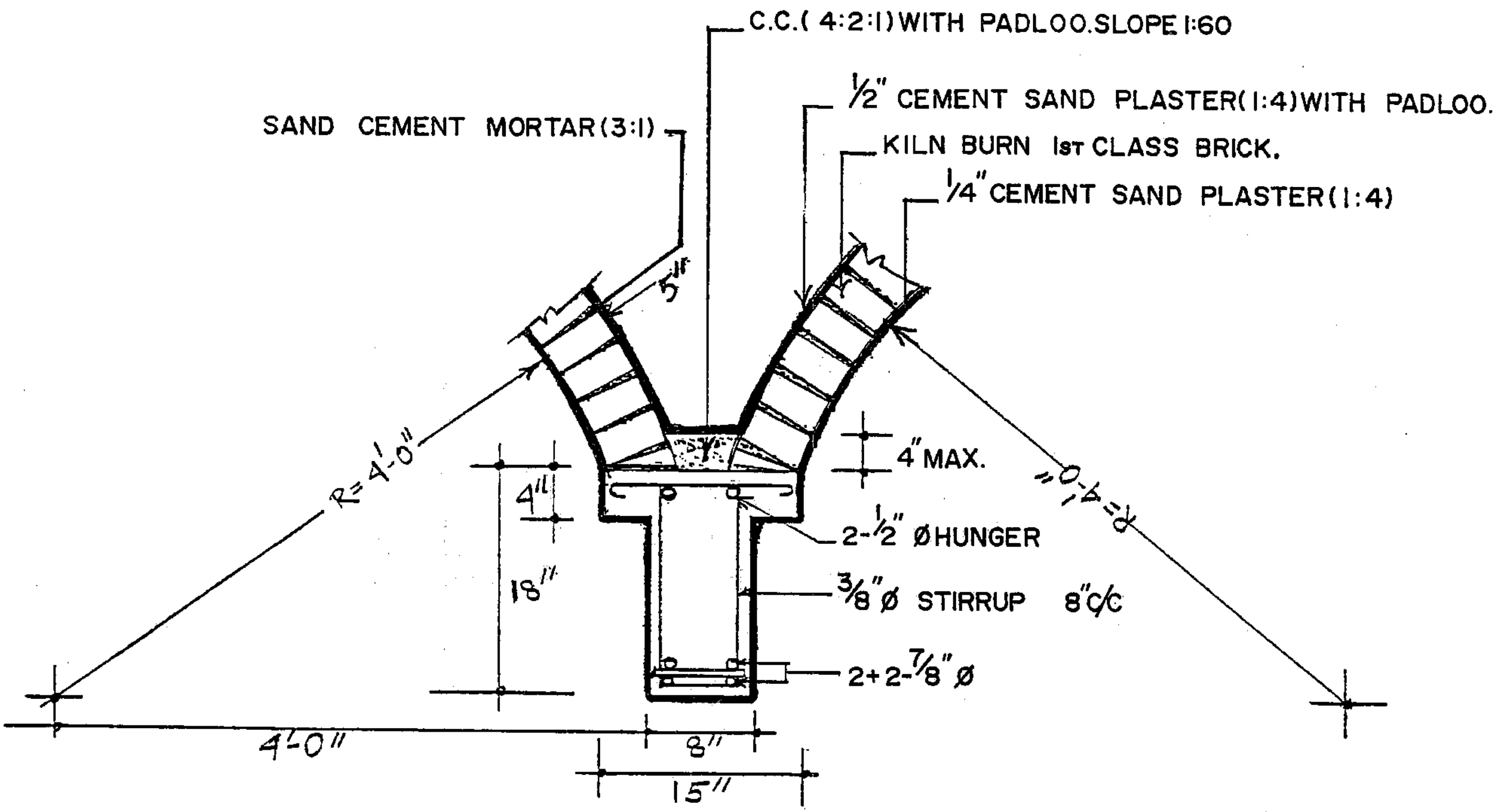

8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
8'-8"
4'-6½"
4'-1½"
2½"
4'-4"
2½"
20'-9"
6'-2½"
20"
15"
15"
20"
15"
15"
11
11
11
11
12
12
13
13
14
14
15
15

TRENCH PLAN

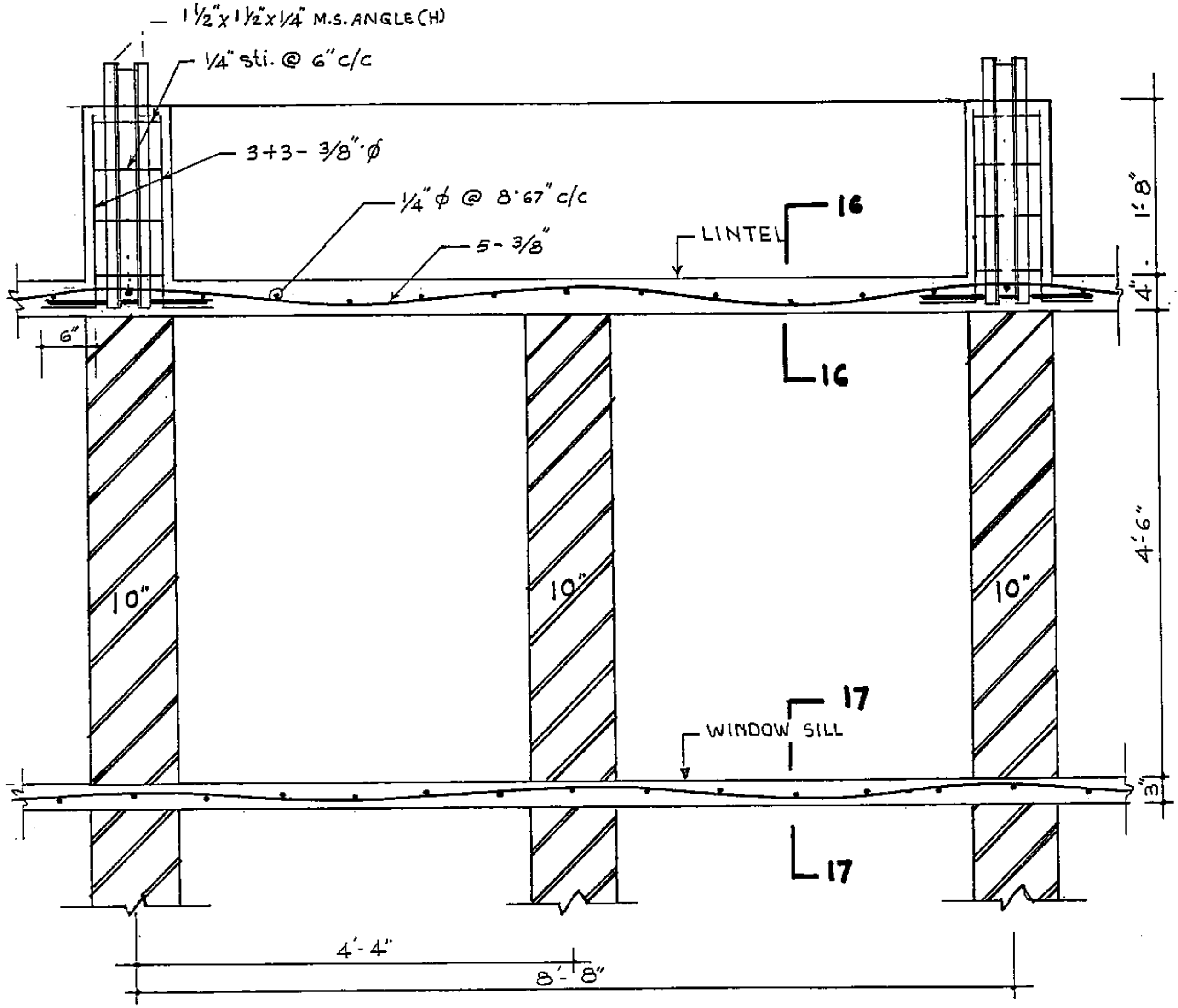


SEC 11-11 SEC 12-12 SEC 13-13 SEC 14-14 SEC 15-15

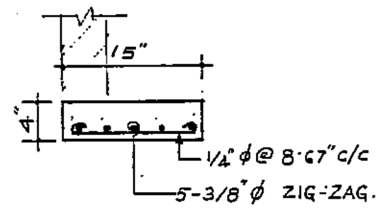

3/8"φ stirrup @8"c/c
1/2"φ hanger
2-5/8"φ hanger
2-5/8"φ
1-7/8"φ Extra
2-7/8"φ
2+2-7/8"φ
1'-0"
5'-0"
1'-6"
6"
4'-0"
1'-0"
3'-0"
4'-5"
8'-4"
6'-3"
20'-4"
1'-3"
7'-3"
7'-2"
7'-2"
6'-3"
7'-8 1/2"
B2
BEAM-B1
2-1/2"φ
1/4"φ @8"c/c
2-1/2"φ
5"
9"
BEAM-B2



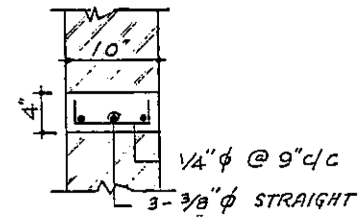
DETAILS OF BEAM B1 AND BRICK ARCH (SEC 1-1)



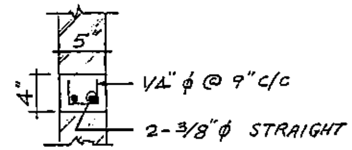
X-SEC. THROUGH LONG WALL



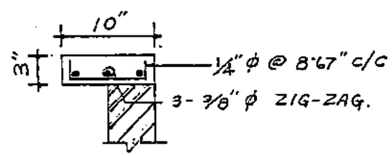
SEC. 16-16



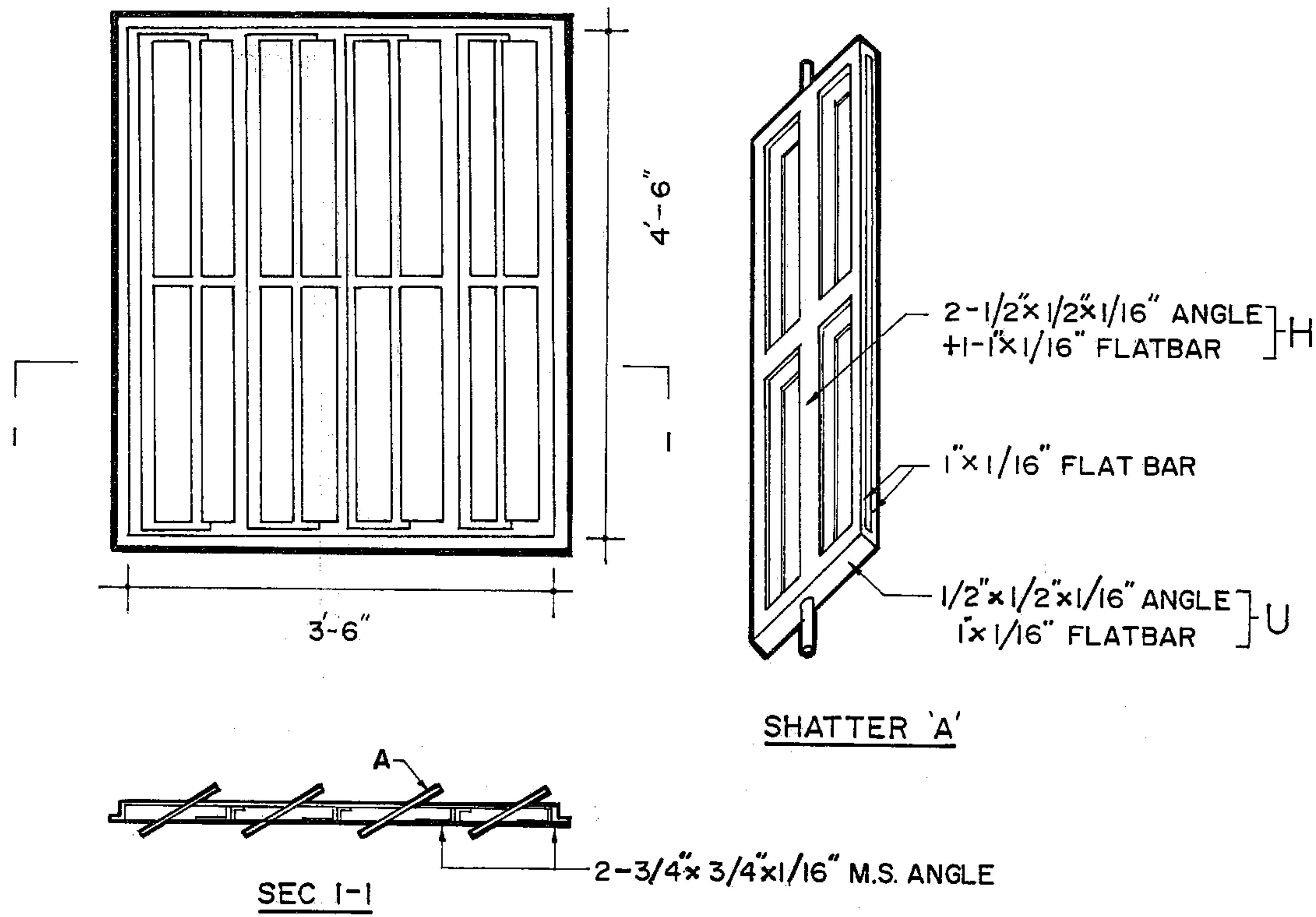
LINTEL AT 10" SOLID WALL



LINTEL AT 5" SOLID WALL



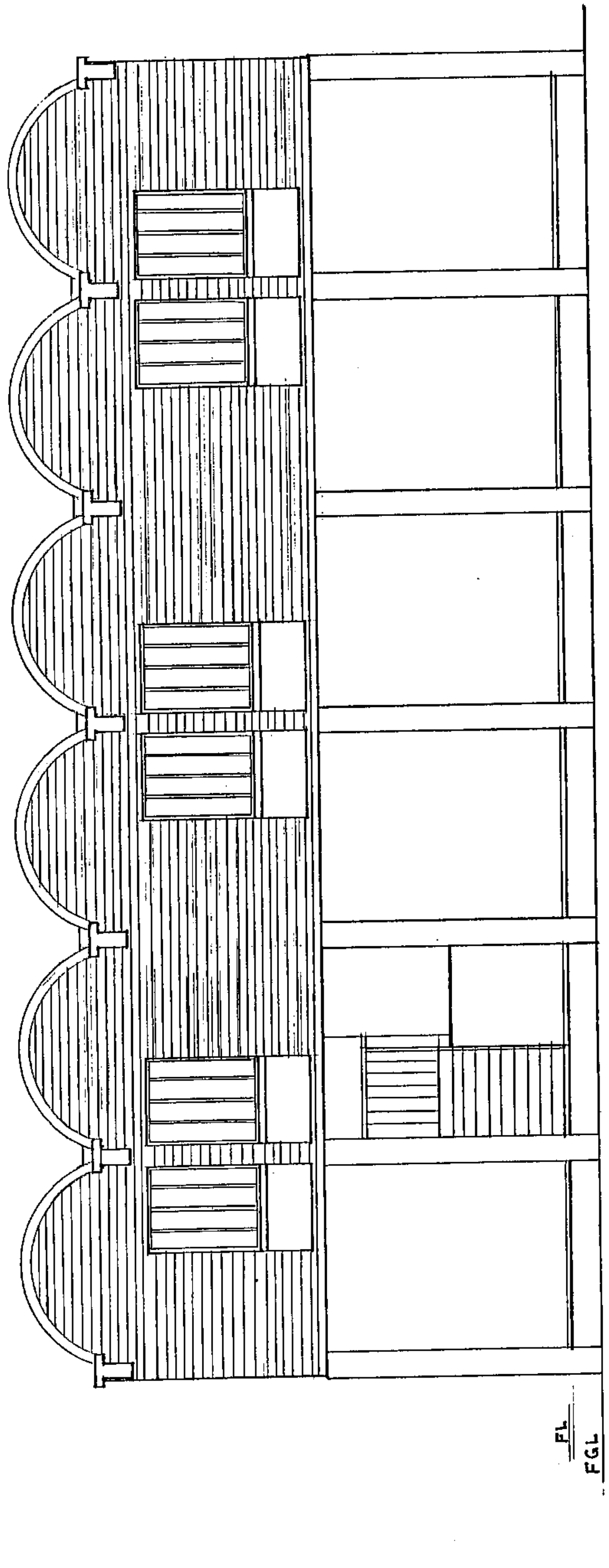
SEC 17-17



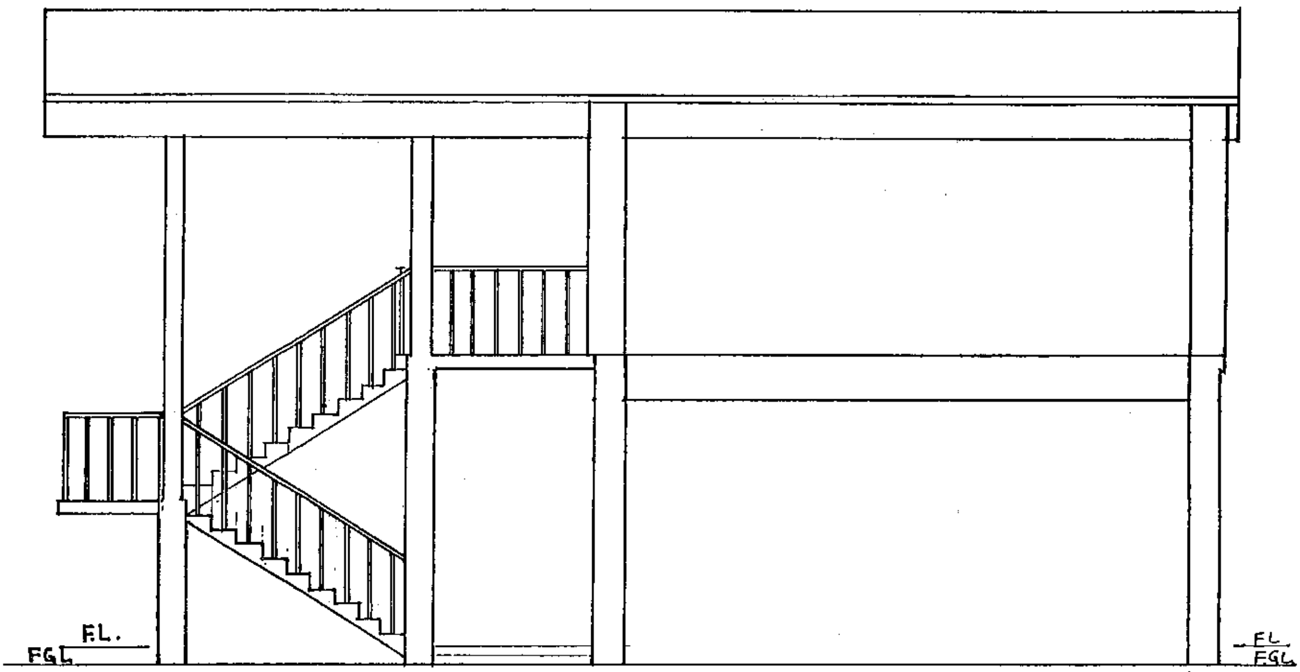
PIVOTED WINDOW

Annex 4. Type C. School: Detailed drawings

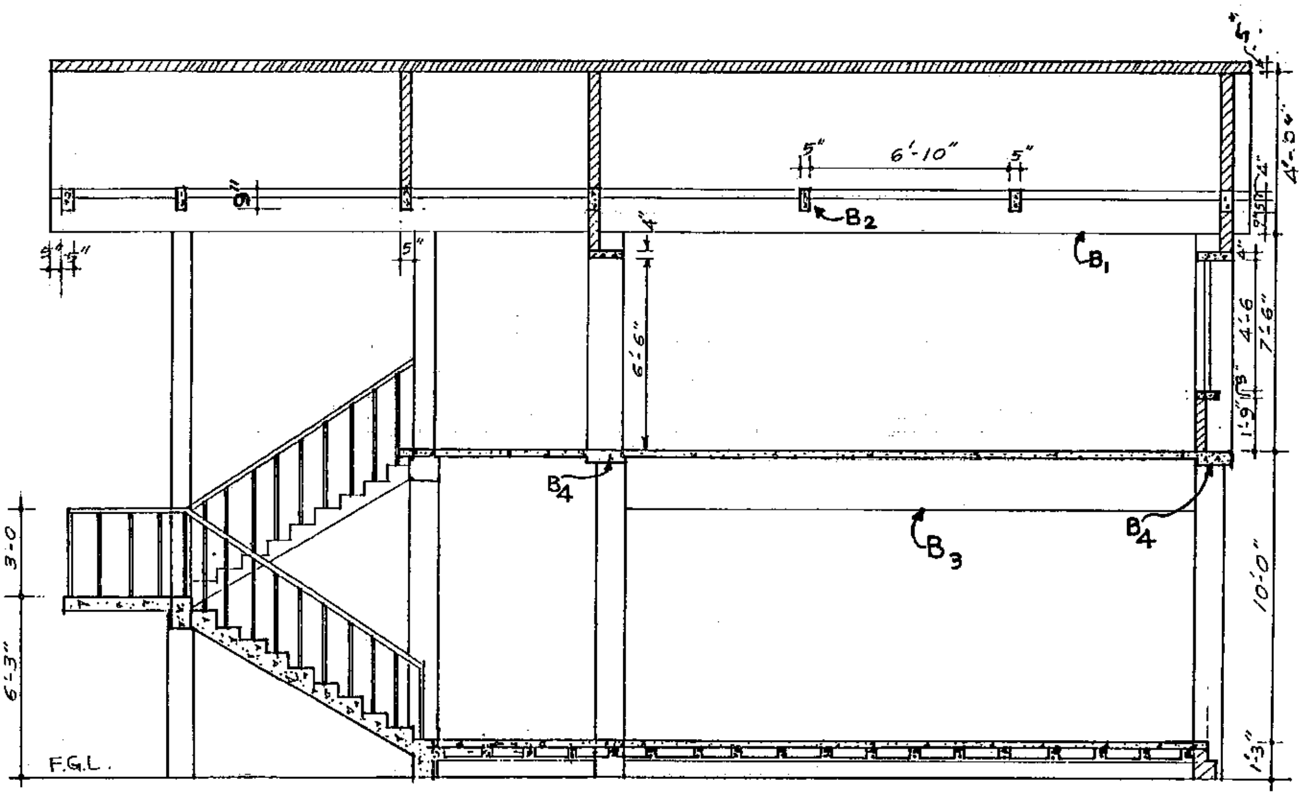
FRONT ELEVATION



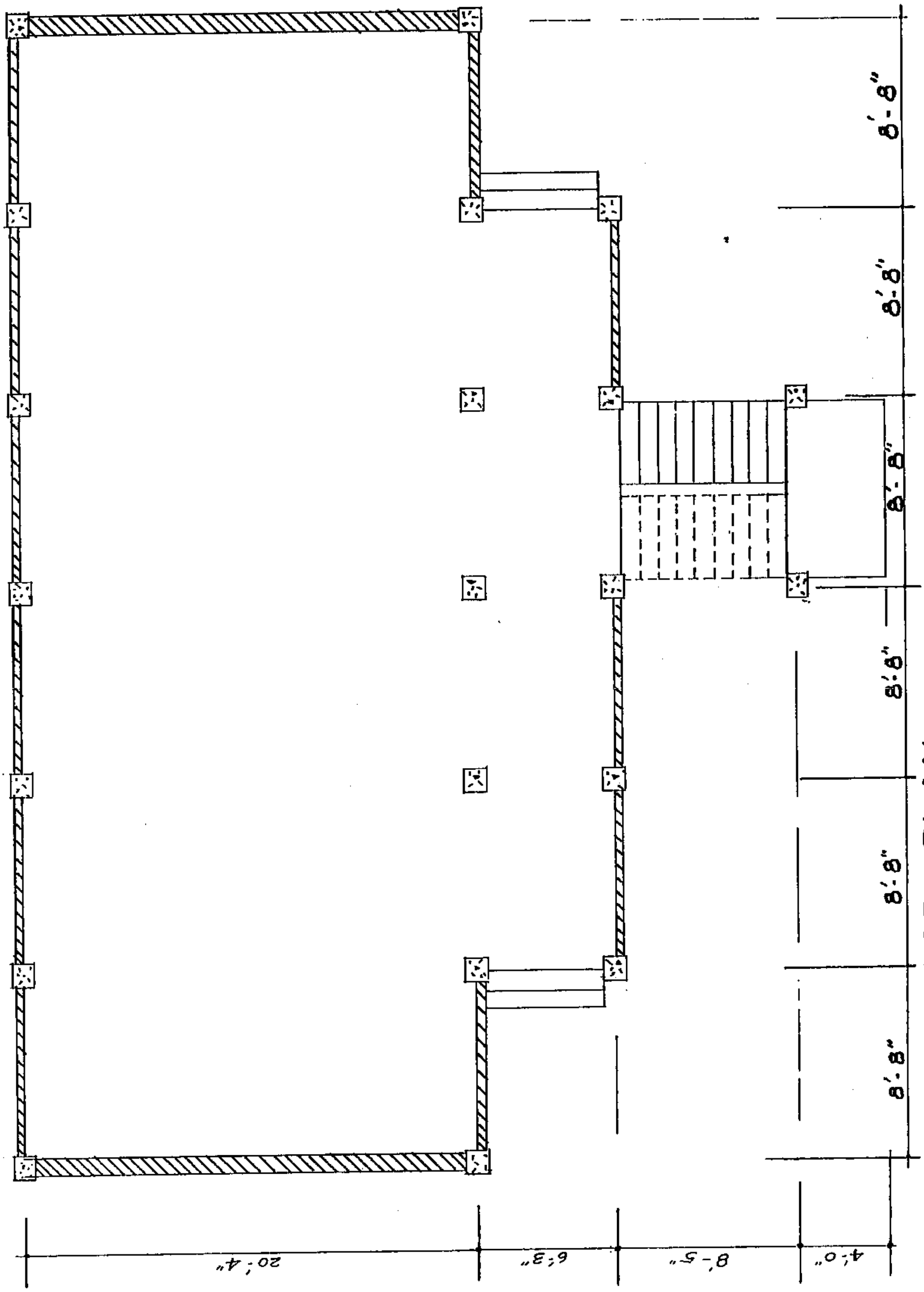
BACK ELEVATION



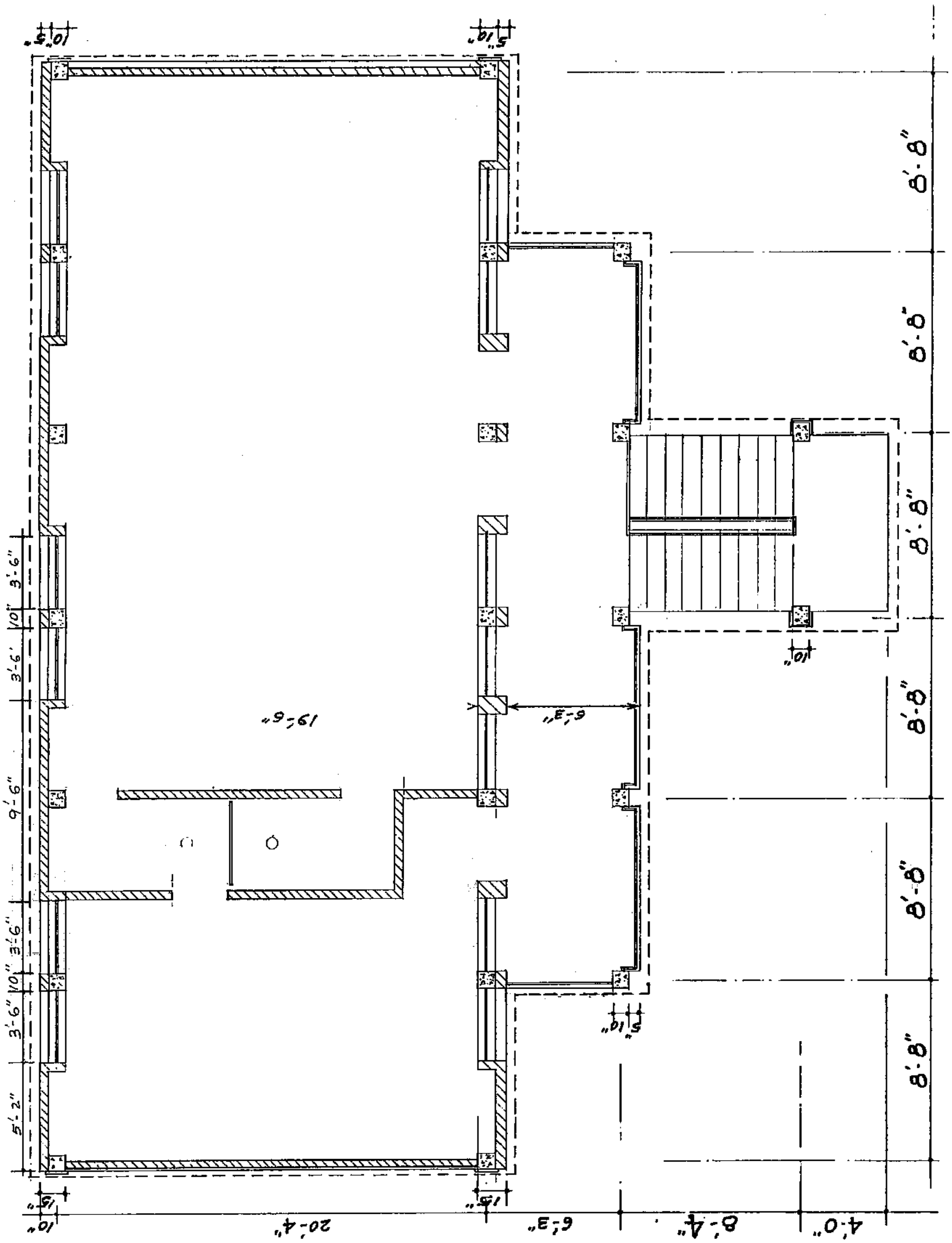
SIDE ELEVATION



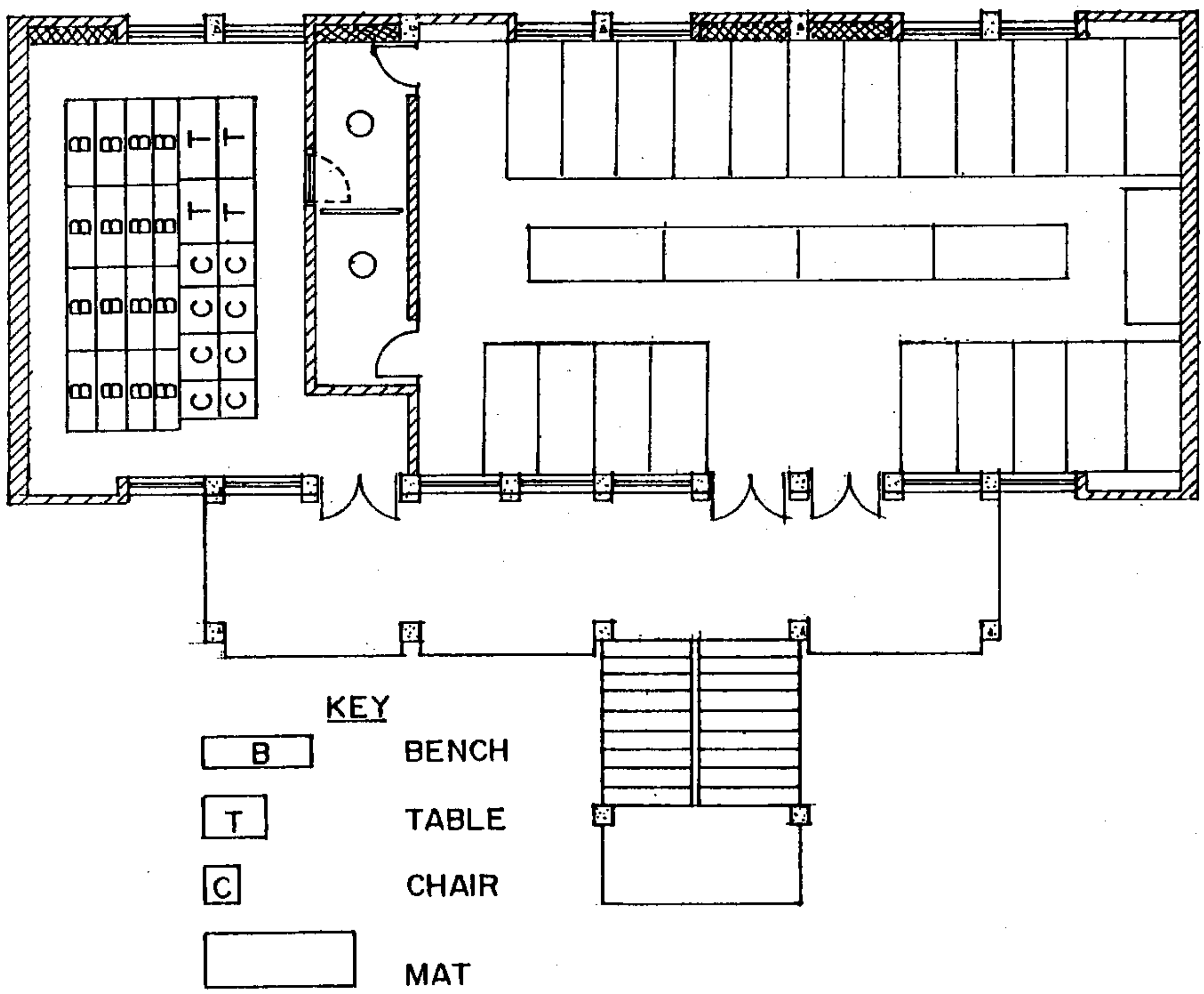
X-SECTION

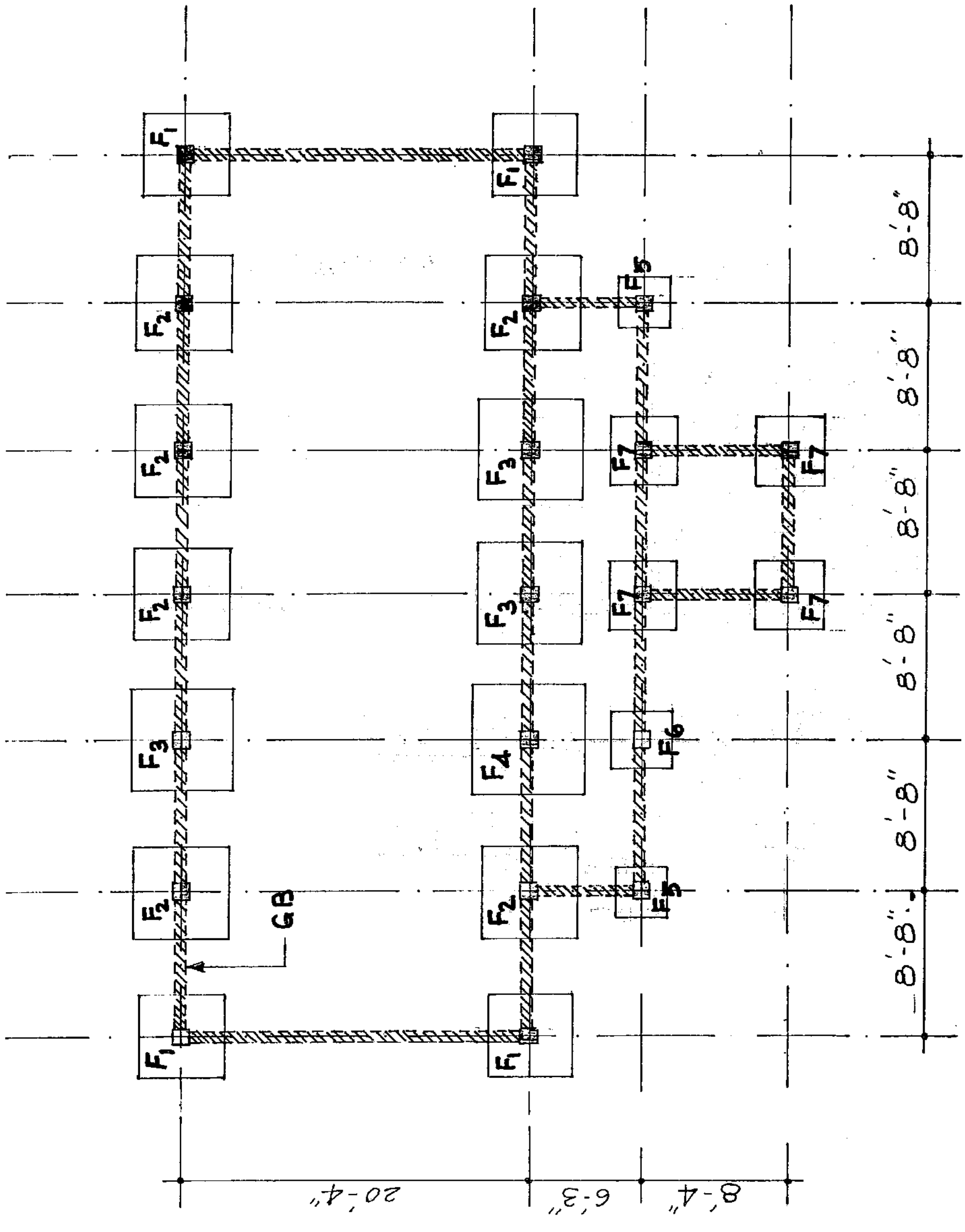


GROUND FLOOR PLAN

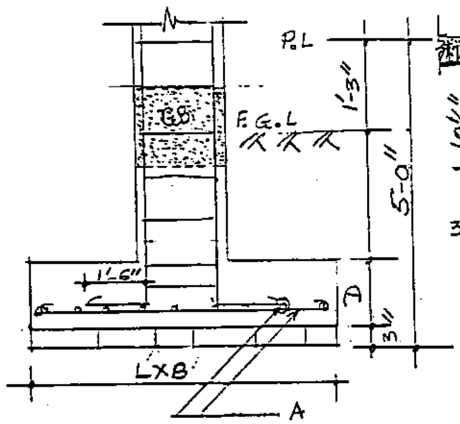


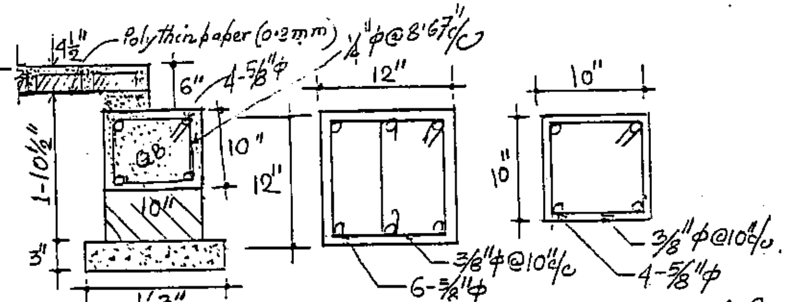
FIRST FLOOR PLAN


KEY
B BENCH
T TABLE
C CHAIR
MAT



TRENCH PLAN





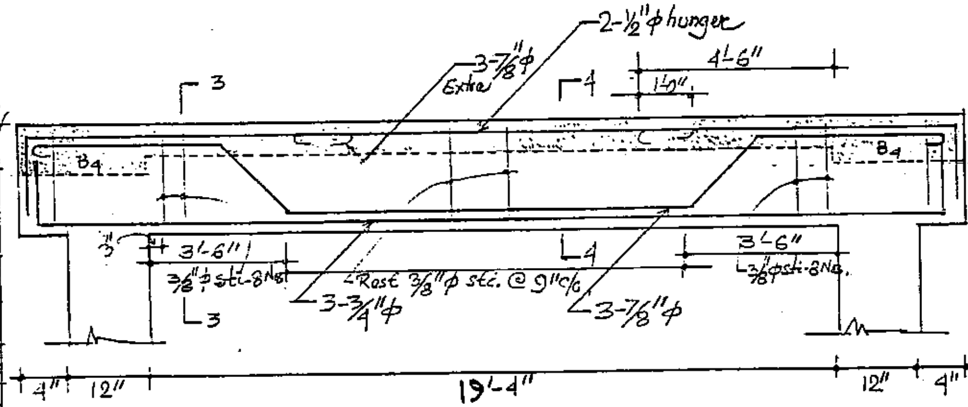
PLINTH WALL

Col. for G. floor.

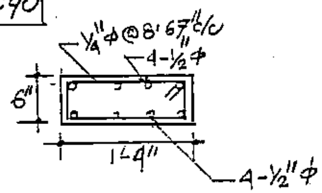
Col. for Ist floor

Schedule of Col. footing

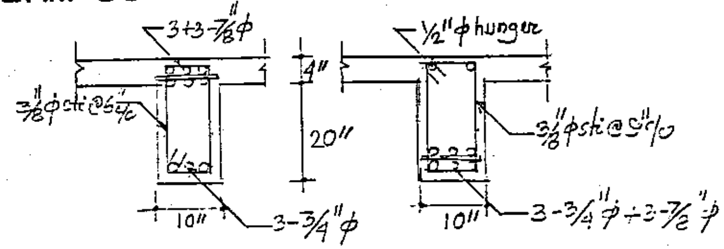
footing	Area L×B	depth D	Reinforcement A
F_1	5'×5'	9"	½"φ @ 5" c/c
F_2	5'-6"×5'-6"	10"	½"φ @ 5" c/c
F_3	6'×6'	11"	½"φ @ 5" c/c
F_4	6'-6"×6'-6"	13"	½"φ @ 5" c/c
F_5	3'×3'	6"	3/8"φ @ 5" c/c
F_6	3'-6"×3'-6"	7"	3/8"φ @ 5" c/c
F_7	4'×4'	9"	3/8"φ @ 5" c/c



BEAM-B3



BEAM-B4



SEC 3-3

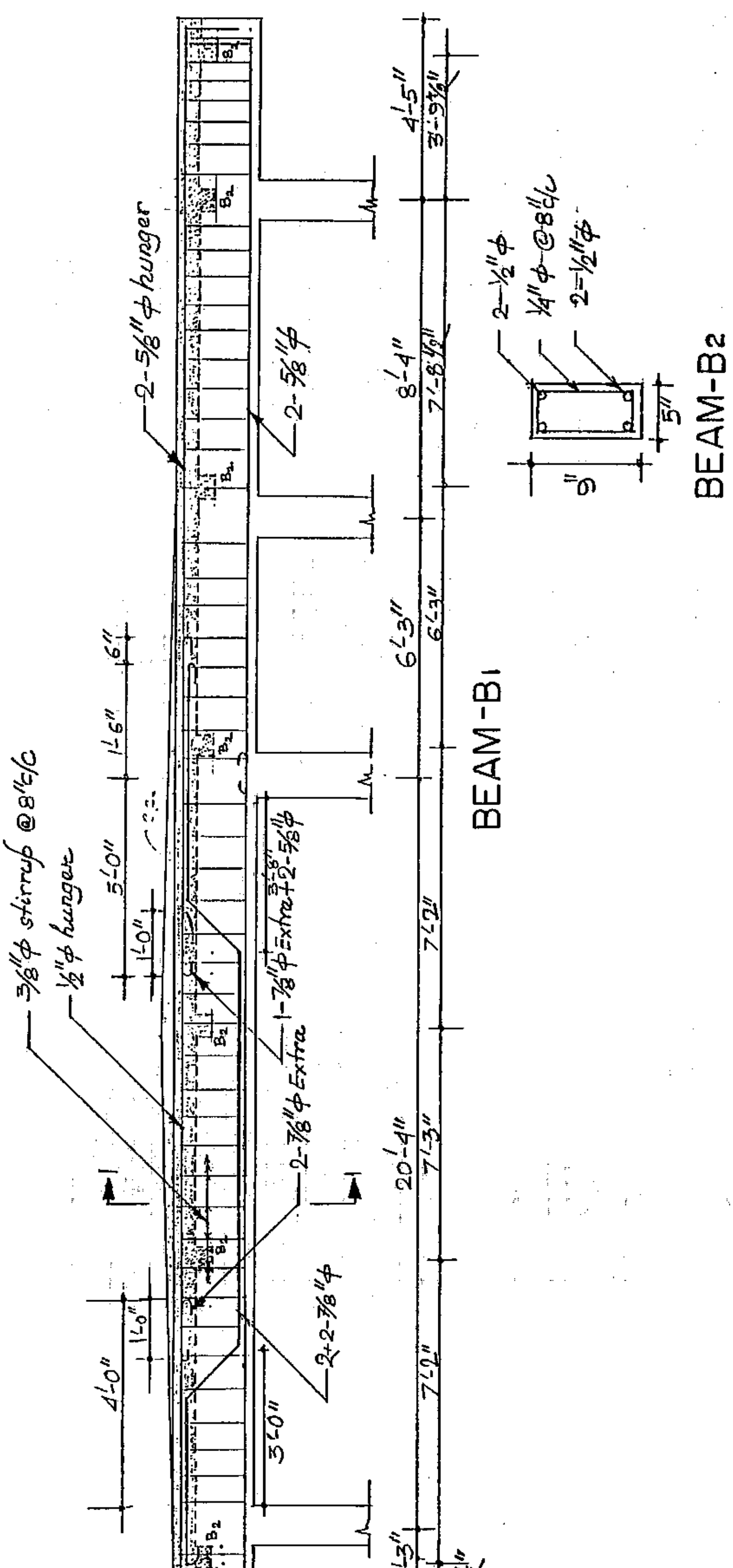
SEC 4-4

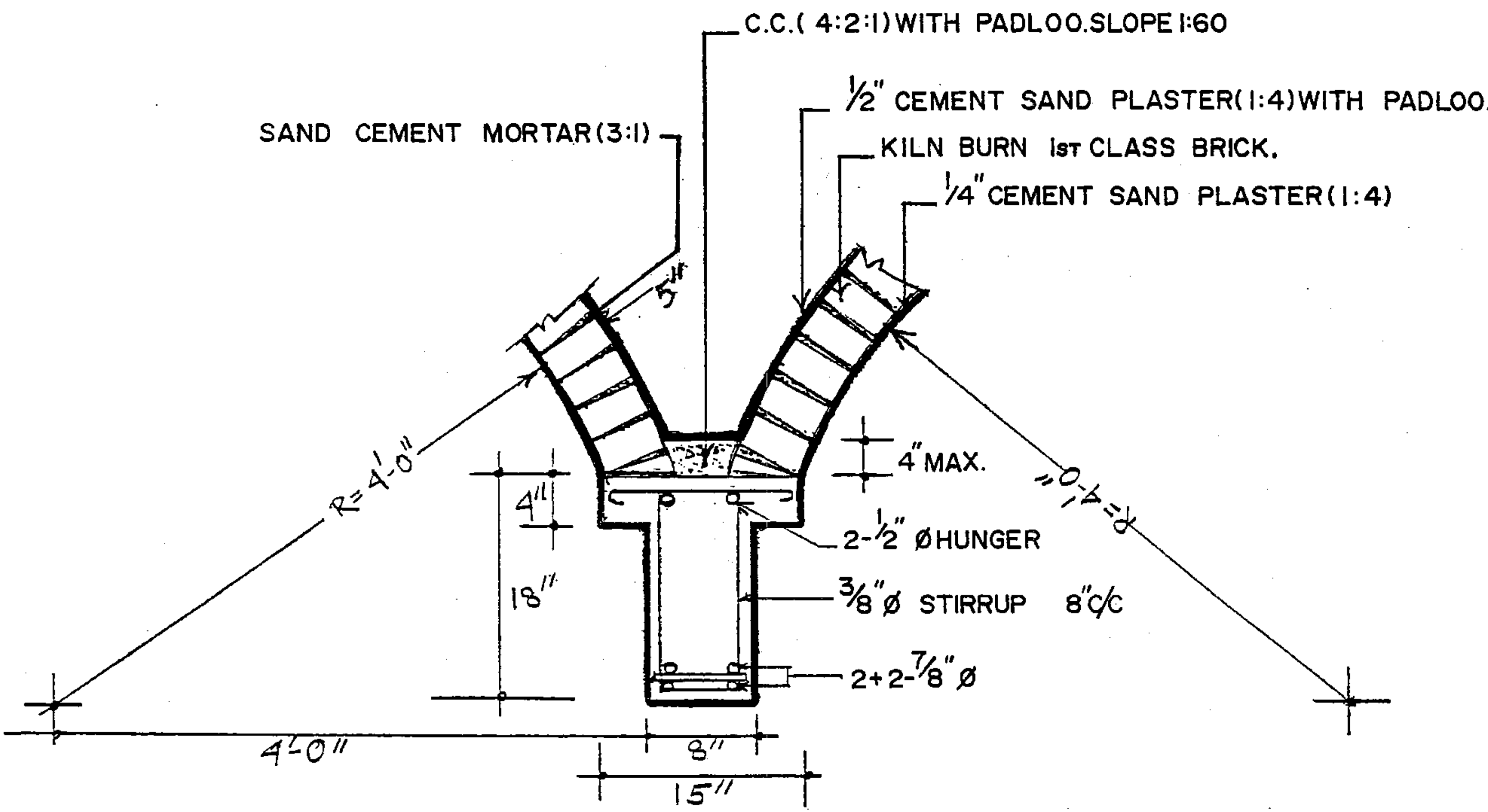
Design data

1. Safe bearing Capacity of soil: $= 0.75$ Tsf
2. $f_s = 18000$ psi
3. $f'_c = 2500$ psi
4. Clear covering
   (a) slab = 3/4" (bot) = ½" (top)
   (b) beam = 1½"
   (c) Col. = below G.L = 2½"
   G. Floor = 2"
   Ist Floor = 1½"
   (d) footing = 3"

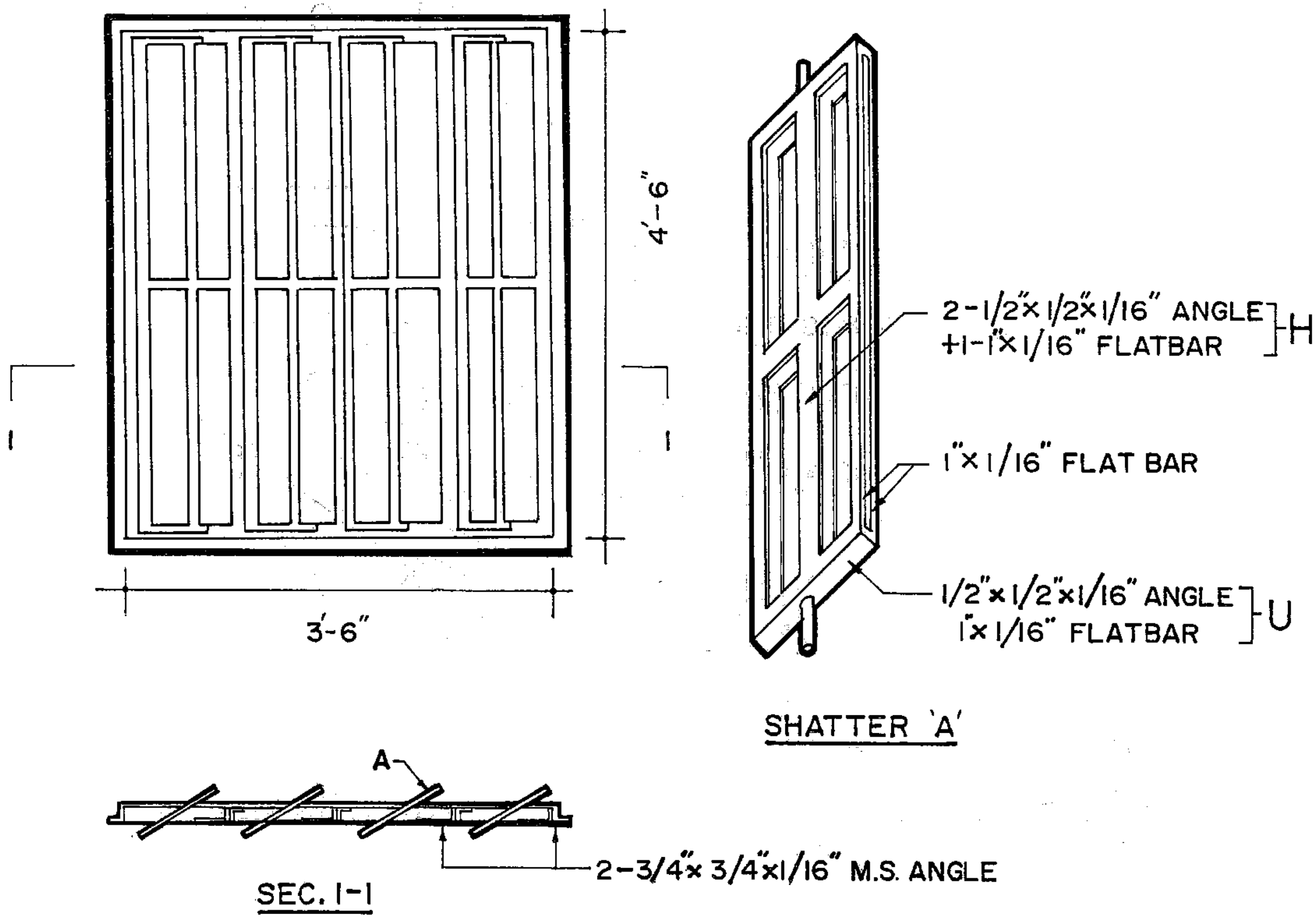
Notes:-

1. Provide 3/8"φ main rod both +ve & −ve zone in floor slab @ 5" c/c and binder both top & bott. In all cases 3/8"φ @ 10" c/c


BEAM-B1
BEAM-B2
2-5/8"φ hanger
2-5/8"φ
3/8"φ stirrup @8"c/c
1/2"φ hanger
1-7/8"φ Extra
1-7/8"φ Extra+2-5/8"φ
2-7/8"φ Extra
2+2-7/8"φ
2-1/2"φ
1/4"φ @8"c/c
2-1/2"φ
4'-5"
3'-9½"
8'-4"
7'-8½"
6'-3"
6'-3"
20'-4"
7'-3"
7'-2"
7'-2"
1'-3"
7½"
4'-0"
1'-0"
3'-0"
5'-0"
1'-0"
1'-6"
6"
9"
5"



DETAILS OF BEAM B1 AND BRICK ARCH (SEC 1-1)



PIVOTED WINDOW

Annex 5. Cost Analysis

SUMMARY COSTS OF PRIMARY SCHOOL CUM FLOOD REFUGE

Current UPE Design

School size:		3 CR
Total area:		1592 sft
Pupil capacity:		288
Area per place:		5.53 sft

Total cost:	Tk. 2,96,000/-	US $8,969.69
Cost per place:	Tk. 1027.77	US $ 31.14
Cost per sft:	Tk. 185.92	US $ 5.63

A. COSTING (Semi pacca building with brick wall & C.I. sheet roofing with M.S. Angle)

Item No.	Description of work	Quantity	Rate per Unit in Tk.	Amount (Taka)
1.	Earth work (foundation trenches)	812 cft	0/525	426.30
2.	Earth filling around the building	2200 cft	0/485	1067.00
3.	Sand filling under floor	2000 cft	4/-	8000.00
4.	Cement concrete (6:3:1)	75 cft	40/25	3018.75
5.	Brick work upto P.L (5:1)	800 cft	31/-	24800.00
6.	Brick concrete (B.C) Floor (4:2:1)	1644 sft	13/50	22194.00
7.	Brick work (5:1) above P.L (10" wall)	381 cft	31/60	12039.60
8.	Brick work (4:1) above P.L (5" wall)	740 sft	13/50	9990.00
9.	R.C.C. work (4:2:1)	200 cft	84/10	16820.00
10.	M.S. Rod	8 cwt	1000/-	8000.00
11.	Plaster (4:1) with neat cement finishing plinth & dado 1/2"	700 sft	4/-	2800.00
12.	All plaster (6:1) 1/2" thick	2900 sft	3/35	9715.00
13.	Pivoted window shutter	315 sft	102/-	32130.00
14.	Timber door shutter (1 1/2" thick)	91 sft	70/-	6370.00
15.	Door frame (1 1/2" x 1 1/2" x 1/4" Angle)	1.40 cwt	1300/-	1820.00
16.	Painting door	200 sft	3/-	600.00
17.	D.P.C.	110 sft	7/96	875.60
18.	White wash	2900 sft	0/30	870.00
19.	Truss, support post, purlin, etc.	42 cwt	1300/-	54600.00
20.	26.B.W.G. C.I. sheet roofing	2285 sft	26/-	59410.00
21.	26.B.W.G. C.I. ridge	120 rft	30/-	3600.00
22.	Nut bolt	350 Nos	5/-	1750.00
23.	Door clamp	16 Nos	15/-	240.00
24.	Tarjamat ceiling	1500 sft	5/-	7500.00
25.	Site clear	L.S.		300.00
				288936.25
			Say	2,89,000/-

$$\text{Cost per sft. Plinth area} = \frac{289000}{1791} = 161/36$$

B. COSTING (Single storey barrel brick Arch building)

Item No.	Description of work	Quantity	Rate per Unit in Tk.	Amount (Taka)
1.	Earth work (foundation trenches)	812 cft	0/525	426.30
2.	Earth filling around the building	2200 cft	0/485	1067.00
3.	Sand filling	2000 cft	4/-	8000.00
4.	Cement concrete	75 cft	40/25	3018.75
5.	Brick work upto P.L	800 cft	31/-	24800.00
6.	Brick concrete (B.C) Floor	1644 sft	13/50	22194.00
7.	10" Brick wall above P.L (5:1)	220 cft	32/-	7040.00
8.	5" Brick wall (4:1)	1396 sft	13/50	18846.00
9.	R.C.C. work (4:2:1)	500 cft	80/-	40000.00
10.	M.S. Rod	40 cwt	1000/-	40000.00
11.	1/2" Plaster 4:1 (plinth & dado) with neat cement	700 sft	4/-	2800.00
12.	1/2" wall plaster (6:1)	3322 sft	3/35	11128.70
13.	1/4" ceiling plaster (4:1)	3025 sft	2/90	8772.50
14.	1/2" roof top plaster (4:1) with Padloo	2330 sft	5/-	11650.00
15.	5" Brick Arch (3:1)	2340 sft	20/-	46800.00
16.	Pivoted window shutter	315 sft	102/-	32130.00
17.	wooden door shutter	91 sft	70/-	6370.00
18.	Door frame 1 1/2" x 1 1/2" x 1/4" Angle	1.40 cwt	1300/-	1820.00
19.	Door clamp	16 Nos	15/-	240.00
20.	Painting	200 sft	3/-	600.00
21.	1/2" D.P.C. (3:1 1/2: 1)	110 sft	7/96	875.60
22.	Whitewash	6622 sft	0/30	1986.60
23.	Site clear	L.S.		300.00
				290865.45
			Say	2,91,000/-

$$\text{Cost per sft. Plinth area} = \frac{291000}{1791} = 162/48 = 162/50$$

C. COSTING (frame structure with brick Arch roof 2-storey)

Item No.	Description of work	Quantity	Rate per Unit in Tk.	Amount (Taka)
1.	Earth work (foundation trenches)	2130 cft	0/525	1118.25
2.	Earth filling around the building	2000 cft	0/485	970.00
3.	Sand filling	1326 cft	4/-	5304.00
4.	Cement concrete (6:3:1)	60 cft	40/25	2415.00
5.	Brick work upto P.L	332 cft	31/-	10292.00
6.	Brick concrete (B.C) Floor	1326 sft	13/50	17901.00
7.	1/2" Plinth plaster (4:1) with neat cement	280 sft	4/-	1120.00
8.	1/4" R.C.C. surface (4:1) and roof	5406 sft	2/90	15677.40
9.	R.C.C. work: footing:-	602 cft	70/-	42140.00
	col:-	424 cft	84/10	35658.40
	beam, slab, staircase:-	1238 cft	80/-	99040.00
10.	M.S. Rod	149 cwt	1000/-	149000.00
11.	10" Brick work (5:1)	300 cft	32/-	9600.00
12.	5" Brick work (4:1)	1360 sft	13/50	18360.00
13.	5" Brick Arch (3:1)	1780 sft	20/-	35600.00
14.	1/2" roof plaster (4:1) with Padloo (top)	1970 sft	5/-	9850.00
15.	1/2" wall plaster (6:1)	3436 sft	3/35	11510.60
16.	Patent stone (3:1 1/2 :1) 1 1/2"	1352 sft	7/96	10761.92
17.	Pivoted window shutter	205 sft	102/-	20910.00
18.	Door shutter (wooden)	68 sft	70/-	4760.00
19.	Painting	153 sft	3/-	459.00
20.	Door frame: (1 1/2" x 1 1/2" x 1/4")	1 cwt	1300/-	1300.00
21.	Clamp:-	12 Nos	15/-	180.00
22.	Whitewash	8842 sft	0/30	2652.60
23.	Site clear	L.S.		500.00
				507080.17
			Say	5,07,000/-

$$\text{Cost per sft. Plinth area} = \frac{289000}{1791} = 161/36$$

COSTING: Sanitary toilet

Item No.	Description of work	Quantity	Rate per Unit in Tk.	Amount (Taka)
1.	Earth work	360 cft	0/525	189.00
2.	Earth filling	100 cft	0/485	48.50
3.	Sand filling (soak pil)	15 cft	10/-	150.00
4.	Brick bats	30 cft	10/-	300.00
5.	Cement concrete (6:3:2)	30 cft	40/25	1207.50
6.	Brick soling	60 sft	5/60	336.00
7.	Brick work up to P.L (6:1)	200 cft	31/60	6320.00
8.	5" Brick work (4:1)	121 sft	13/50	1633.50
9.	R.C.C. work (4:2:1)	35 cft	84/10	2943.50
10.	M.S. Rod	117 cwt	1000/-	1700.00
11.	Brick work for Arch (3:1)	68 sft	20/-	1360.00
12.	1/2" Plaster (6:1)	850 sft	3/35	2847.50
13.	Door shutter (26 B.W.G. Plane sheet)	33 sft	50/-	1650.00
14.	Painting	80 sft	3/-	240.00
15.	Patent stone in floor	18 sft	7/96	143.28
16.	Whitewash	400 sft	0/30	120.00
17.	Gas vent (2" H.C.I.)	10' 0"	70/-	700.00
18.	H.C.I. Tee for soak well	1 No.	200/-	200.00
				22088.78
			Say	22100/-

COST OF PRIMARY SCHOOL-CUM-REFUGE SHELTER

Type A.	Semi-pacca building with brick wall and C.I. sheet roofing with Ms. Angle	School size:		3 CR
		Total area		1791 sft
		Pupil capacity		336
		Area per place		5.97 sft
		Total Cost	Tks.2,89,000/-	US $8,757.58
		Cost/place	860/12	26.06
		Cost/sft	161/36	4.89
Type B.	Pacca building with brick wall and 5" brick barrel Arch roofing	School size:		3 CR
		Total area		1791 sft
		Pupil capacity		336
		Area per place		5.97 sft
		Total Cost	Tks.2,91,000/-	US $8,818.18
		Cost/place	866/07	26.25
		Cost/sft	162/48	4.92
Type C.	2-storeyed placed building frame structure with brick wall and 5" brick barrel Arch roofing	School size:		5 CR
		Total area		2978 sft
		Pupil capacity		480
		Area per place		6.20 sft
		Total Cost	Tks.5,07,000/-	US$15,363.64
		Cost/place	1056/25	32.00
		Cost/sft	170/25	5.16
		Size:		2 units
	Latrine (Aqua Privy)			
	Latrine (Water seal)	Total cost	Tks. 22100/-	US $ 770.00

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