National Disaster Management Agency
The Republic of Indonesia

No.

Urgent Project on Reconstruction of Schools Considering Quake-Resistance and Community based Disaster Risk Management in the Province of West Sumatra in the Republic of Indonesia

Manual for Safe School Construction

AUGUST 2011

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

YACHIYO ENGINEERING CO., LTD
OYO INTERNATIONAL COOPERATION

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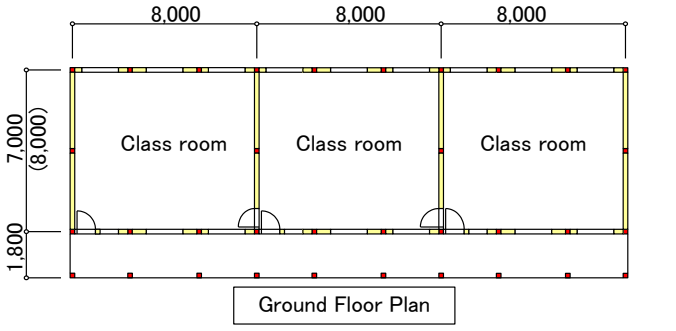
MANUAL FOR SAFE SCHOOL CONSTRUCTION

Table of Contents

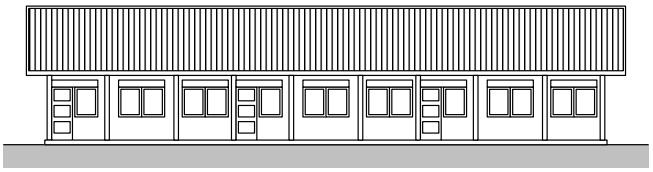
1. School Construction Design

1.1 Actual Situation of School Design

Schools in Indonesia are designed based on the school facility standards and guidelines formulated by the Ministry of National Education. However, the facility standards and guidelines mainly refer to such modules as the type of rooms to be built and standard dimensions with no coverage on structural standards.

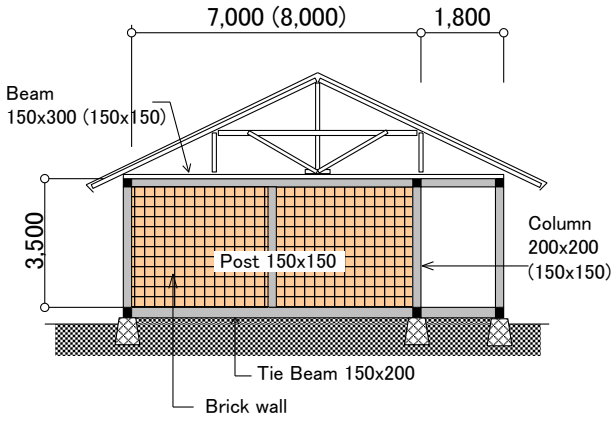


Ground Floor Plan

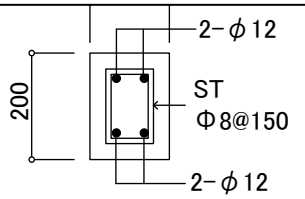


Elevation

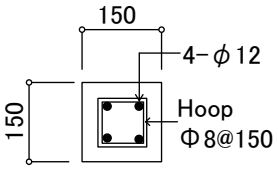
Floor Plan and Elevation of Standard Indonesian Schools



Sectional View of Standard Indonesian Schools



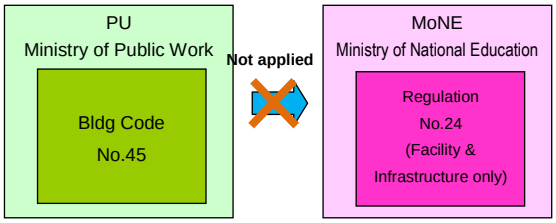
Sectional View of Beams of Standard Indonesian Schools



Sectional View of Pillars of Standard Indonesian Schools

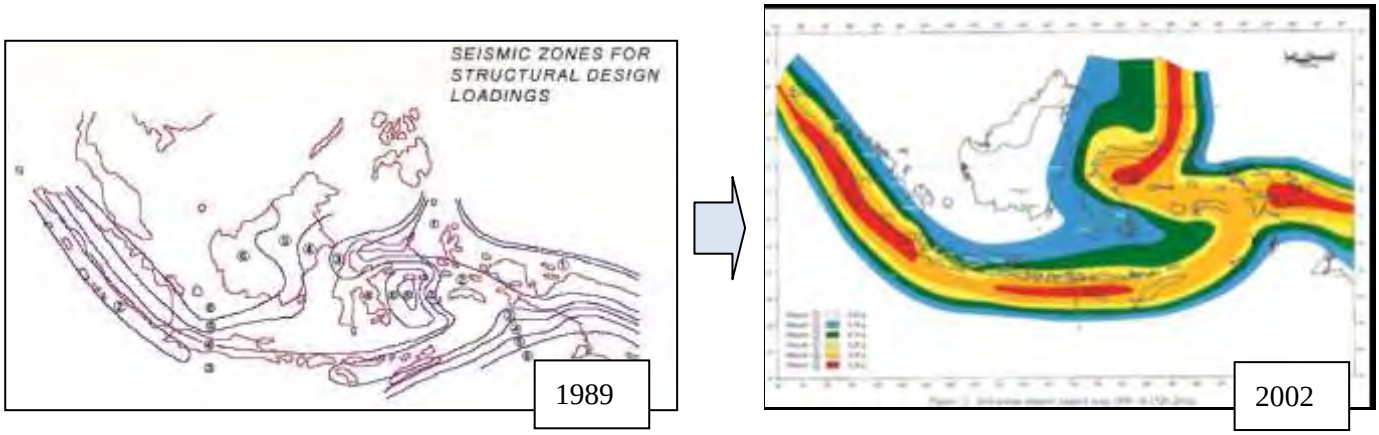
Schools in Padang Pariaman District are constructed with thin pillars and beams and regular reinforcing bars after the earthquake in the same manner as before the earthquake. Schools that are newly built with AudAID are also built in accordance with the standards and guidelines. This shows that school construction are not following revisions of Indonesian seismic standards that were revised in 2002 and 2010.

1.2 Actual Situation of Relationship between Indonesian Ministries

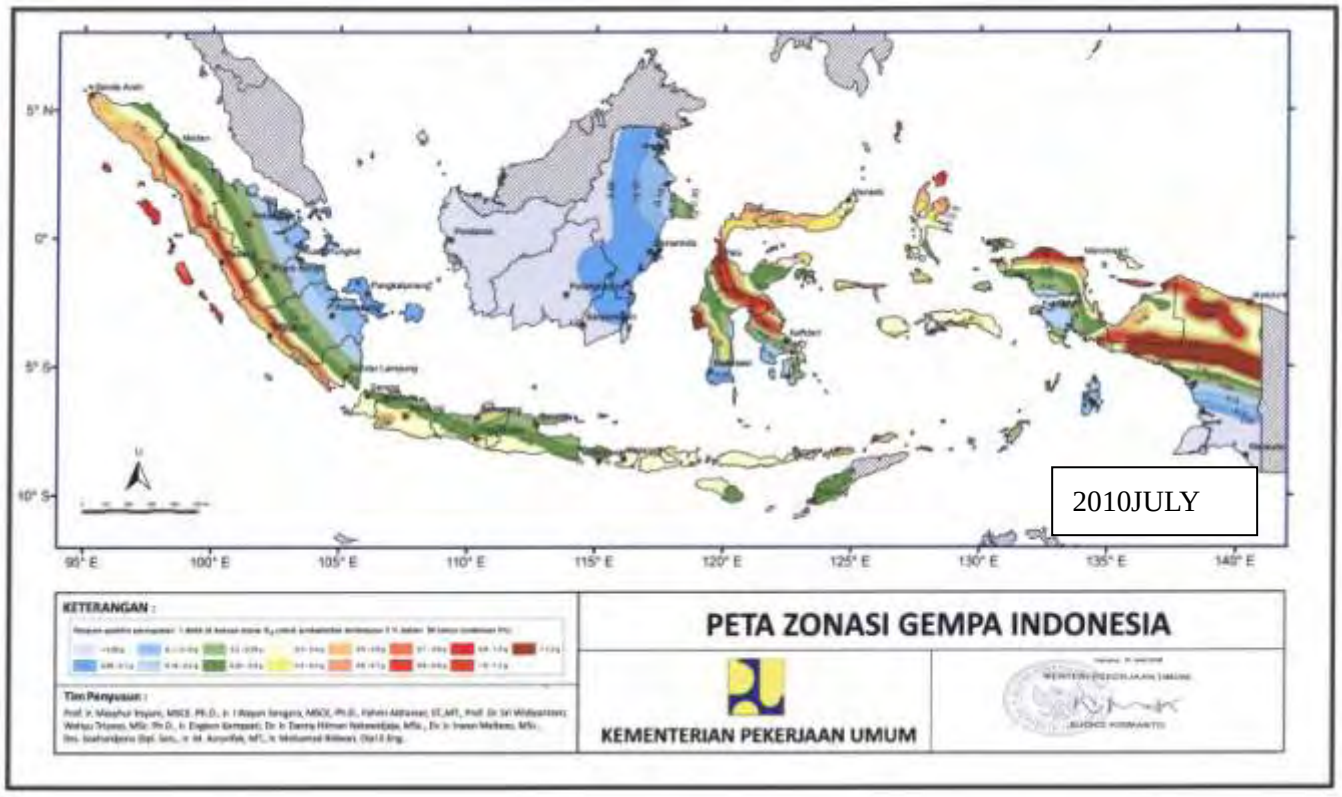


The ministerial order of the public works project No45/PRT/M/2007 contains a description in "Considering e" that public buildings constructed with the national budget are required to comply with the standards of the ministry. Article 1-1 in the order also states the definition of public buildings and "school buildings" are included in the category. Thus, all public buildings in Indonesia are under the supervision of the ministry of public works projects (PU). However, school buildings are mainly built with the budget of the Ministry of National Education and foreign aid and thus the design and quality control of school buildings do not necessarily satisfy the standards of the ministry of public works projects. For example, although no quake-resistance was taken into consideration in the construction of schools built by AusAID and local builders as contractors after the earthquake off the coast of Padang Pariaman, construction permits were issued and the schools are currently used. Because there is no section of quake-resistance techniques within the Ministry of National Education, schools continue to be built with no revisions of structural issues that affect the quake-resistance although there are criteria for standard modules. AusAID outsources design and supervision work as a package to local consulting agencies based on the standards of the Ministry of National Education. Thus, although it adopts revisions of the standards if any changes are made, it has no communication with the ministry of public works projects. Laws and regulations need to be observed and the two ministries are expected to work together as an effort to ensure compliance with construction and design standards.

1.3 Reform of Indonesia Seismic Criteria



The national seismic criteria (SNI-03-1726-2002/2003) were revised in 2002. Compared with former criteria, the story shear force coefficient is twice as much as the former criteria. Furthermore, Indonesian PU issued the Zone Map of Earthquake Region-PU in July 2010 and is planned to be used for quake-resistance design.



(Zone Map of Earthquake Region-PU)

1.4 Need for Revision of School Standard Drawings of Ministry of National Education

As quake-resistance of public buildings has drawn attention in Indonesia, revisions of the standard drawings of the Ministry of National Education have lagged behind, while the nation recognizes the need for quake-proof school buildings as it knows how much damage was caused to school facilities by the Sumatra earthquake and the earthquake on the eastern island of Java. .

Against the backdrop, the study team proposed and agreed on the addition of standard structural drawings in consideration of quake-resistance to standard drawings of the Ministry of National Education.

1.5 Method of Standard Design Creation

1.5.1 Basic Policy

(1) Purpose of Creating Standard Drawings

It is to design structures of primary schools and junior high schools based on the Indonesian quake-resistance criteria to add to the standard design document (reference document) for these schools of the Ministry of National Education and propose standard cross-sections of structural

members for each earthquake zones.

(2) Target of Creation of Standard Drawings

As target school buildings for the creation of standard drawings, two types of most standard school buildings were chosen: ① one-story building with six classrooms and ② two-story building (three classrooms and toilet on the first floor and three classrooms and teachers' room on the second floor). The dimensions of the classroom are 7 meters x 8 meters in accordance with Indonesian standard.

(3) Quake-Resistance Criteria to be Used

The recovery assistance project was designed based on the SNI03-1726-2002 and 2003 quake-resistance design guidelines. However, the seismic force is calculated and suggestion is made based on the Zone Map of Earthquake Region-PU issued by the Indonesian PU in 2010 for this study.

(4) Zoning Policy

According to the zone map published by the PU, the nation is categorized into 16 zones. However, if design is made for the 16 zones, there may be too many designs and it may cause confusion. Thus the 16 zones are re-categorized into the following four zones based on the peak response acceleration as a result of examination:

① Maximum zone (0.3)
② Medium zone 1 (0.2)
③ Medium zone 2 (0.1)
④ Minimum zone (0.013)

Map 1.5.1 Seismic Hazard Map

1.5.2 Structural Analysis Method

There is no original structural design standard in Indonesia and it usually uses the American Concrete Institute (ACI) standards. Ultimate design is used as the design method. However, FEMA-302 edited by the BSSC (USA) is used only for seismic force calculation. SAP2000V.12 is used as software for structural design and 3D model is used for analysis.

1.5.3 Calculation of Seismic Force

R:	Structure-property coefficient (RC moment form)	5.0
I:	Building importance factor	1.25
T:	Proper period of building (computation result)	
W:	Building weight	
SDS:	short-period design spectrum response acceleration (values in MAP 6)	
SD1:	1-second-cycle design spectrum response acceleration (values in MAP 2)	

Seismic Base Shear Coefficient CS

It is calculated with the short-period and 1-second-cycle spectrum response acceleration based on the following three formulas:

CS3 = 0.1 × SD1 × I

CS2＝ SDS / (R / I)

CS1= SD1 / (T × (R / I))

When the calculation results are:

CS3 ≦ CS2 ≦ CS1, then Cs=CS2

CS3 ＞ CS2, then CS=CS3

CS2 ＞ CS1, then CS=CS1

Cs is confirmed and is multiplied by the building weight to obtain the horizontal force.

V = CS × W

The horizontal force of each floor of two-story buildings is obtained in the following formula when Wi indicates the weight of floor i and Hi indicates the height of floor i from the first floor:

V2 = V × (W2×H2 / （W2×H2＋W1×H1）)

V1 = V × (W1×H1 / （W2×H2＋W1×H1）)

1.6 Construction Cost Increase due to Seismic Design (estimate)

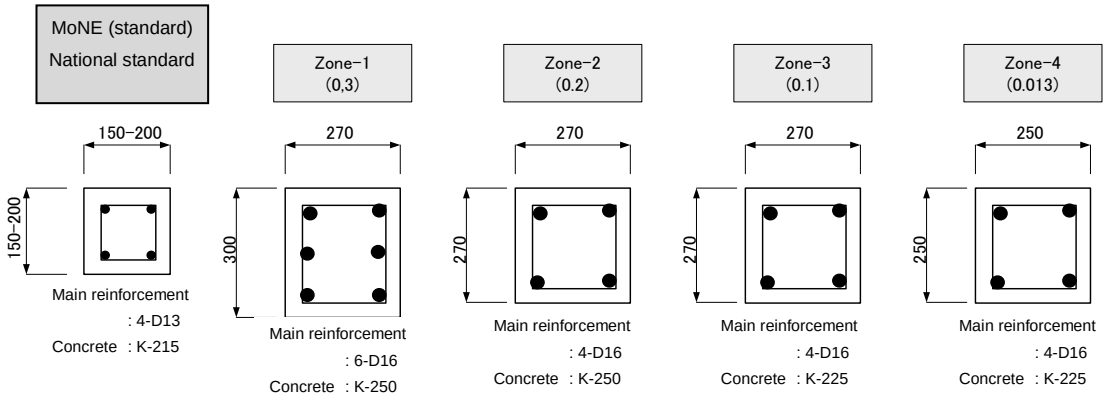


Figure 1.6.1 Pillar Cross-Section

The figure 1.6.1 above shows a comparison of pillars. When seismic design is applied, pillars and beans become bigger and the amount of reinforcement also increased. As a result, the construction cost increases. According to an estimate, the total construction cost is seven percent to 14 percent more than that of the standard of the Ministry of National Education.

1.7 Summary and Utilization of Investigation Results

The investigation results are summarized in the form of standard drawings and delivered to the Ministry of National Education. We received a letter from the ministry in which it says that it will utilize it in the future. Although the ministry was willing to accept the need for quake-resistant school construction immediately after earthquakes, it is concerned about the cost increase as it requires national budget increase as well as influence on other donors and it is hesitant to switch the importance from ①quantity than quality to ② quality than quantity. The recognition seems to be spreading gradually as the nation requested submission of electronic data of the map of seismic zone created by the study team and the Padang Pariaman requested the submission of school design drawings used for model school construction and grant aid project with the purpose to use them as a model for future school construction.

2. Construction Supervision Manual

2.1 Contents

A construction supervision manual was compiled based on the problems and lessons learned from the model school construction project (described in the Model School Construction Report) and it was used for supervision of school construction that was implemented in the grant aid project. The manual consists of the following topics:

Part-1: Basic knowledge on reinforced concrete structure

(1) Concrete behavior
(2) Cement behavior
(3) Concrete characteristics
(4) Reinforced concrete mechanism
(5) Trial mixing

Part-2: Basic manual on construction works

(1) Concrete construction
(2) Formwork Construction
(3) Reinforcement Placing
(4) Material Management Methods

2.2 Effectiveness

The effectiveness of the construction supervision manual is described in the Model School Construction Report. The public works ministry of Padang Province in Indonesia evaluated the contents in a letter which says that it is effective in requiring construction companies to perform supervision works by attaching it to future public works contracts.

According to the public works ministry of Padang Province, it is distributing the manual to PU regional offices (19 regions in West Sumatra) so that it will be used for new buildings. Although a “manual” is not legally effective, it can become mandatory for contractors when it is attached to the contract document and thus supervision by the ministry of public works projects and local consulting agencies can become mandatory.

Attachment-1: Letter of agreement on quake-resistant school construction from the Ministry of National Education

MEETING MEMORANDUM
ON
PROCESS OF MAKE-UP QUAKE RESISTANCE SCHOOL BUILDING STANDARD

Name of the Project
■ URGENT PROJECT ON RECONSTRUCTION OF SCHOOLS CONSIDERING QUAKE-RESISTANCE AND COMMUNITY BASED DISASTER RISK MANAGEMENT IN THE PROVINCE OF WEST SUMATRA IN THE REPUBLIC OF INDONESIA

1. Based on the discussion thorough the captioned project, and Work-shop held on 26th August 2010, Ministry of National Education (hereinafter referred to as "MoNE") and Japan International Cooperation Agency (referred to as "JICA") has a consensus of importance of make up Quake-resistance school building standards so that to avoid huge damage by the earthquake disaster in future to the educational national assets and human resources.

2. And also, the both parties confirmed that Seismic zoning system in Indonesia is updating rapidly by seriously concerned about the recent disaster situation, however, the present MoNE's school building structural standards shown in "Perunjuk Teknis" is not conforming to the new seismic standards stipulated by SNI.

3. In this regards, both MoNE and JICA came to have same consideration about the necessity of taking action for improvement of MoNE's guideline.

4. Upon getting mutual consensus, as an initial administrative procedure, MoNE expressed to try to get internal consensus in the Ministry about make-up new standards conforming to quake-resistance design, and after, according to the MoNE's principals, JICA Team will cooperate and start preparing the draft of new standards jointly with Technical Team of MoNE.

5. Tentatively, the target schedules of process discussed as follows;
   (1) MoNE's internal administrative procedure will be completed up to the end of October 2010 and result will be informed to JICA office by letter.
   (2) Draft of New guideline will be completed up to end of December 2010.
   (3) Authorization process and issue guideline namely "Perunjuk Teknis 2011" will be completed up to May 2011.

Mr. Bambang Indriyanto
Secretary of General
Directorate of Primary and
Secondary Education Management
Ministry of National Education

Mr. Kiichi TOMIYA
Senior Representative
Japan International Cooperation Agency
Indonesia Office

Mr. Hisayuki Yamamoto
Deputy Team Leader of JICA Project

Attachment-2: Letter of acceptance of standard drawings of school construction by seismic zone from the Ministry of National Education

KEMENTERIAN PENDIDIKAN NASIONAL
DIREKTORAT JENDERAL PENDIDIKAN DASAR
Jalan Jenderal Sudirman, Senayan, Jakarta 10270
Telepon: 5725058, Faksimili: 5725608
Laman: www.kemdiknas.go.id

TANDA TERIMA

Sudah diterima dari: JICA STUDY TEAM, 4 (empat) set Buku Prototype Bangunan Sekolah Dasar (Bangunan Sekolah Tahan Gempa Tantai 1 dan 2), dimana buku panduan tersebut akan sangat bermanfaat untuk pembangunan sekolah-sekolah di masa yang akan datang.

Jakarta, 19 Mei 2011
Yang menerima,
Sekretaris Direktorat Jenderal,

Dr. Bambang Indriyanto
NIP. 195309101983031001

Attachment-3: Letter received from the Ministry of Public Works Projects of Padang Province, Indonesia

PEMERINTAH PROVINSI SUMATERA BARAT

DINAS PRASARANA JALAN, TATA RUANG DAN PERMUKIMAN

Jalan Taman Siswa No. 1 Telp. 7051700 - 7051756 - 7051765 Fax. (0751) 7051783 Padang
http://www.sumbarprov.go.id - email: pdeisb@sumbarprov.go.id

TANDA TERIMA

Sudah terima dari **JICA STUDY TEAM**, empat buku **MANUAL KONTROL PEKERJAAN BETON**, yang mana manual tersebut akan dilampirkan dalam dokumen kontrak untuk setiap kontrak pembangunan di masa yang akan datang.

Padang, 26 Mei 2011

Yang Menerima,
Kepala Dinas Prasarana Jalan,
Tata Ruang dan Permukiman

PEMERINTAH PROVINSI SUMATERA BARAT
DINAS PRASARANA JALAN TATA RUANG DAN PERMUKIMAN

Ir. SUPRAPTO, M.Si
NIP. 19561219 198511 1 001

ANNEX

MINISTRY OF NATIONAL EDUCATION

DRAWING

PROTOTYPE ELEMENTARY SCHOOL BUILDINGS

JAPAN INTERNATIONAL COOPERATION AGENCY

QUAKE-RESISTANCE SCHOOL BUILDING
ONE-STOREY

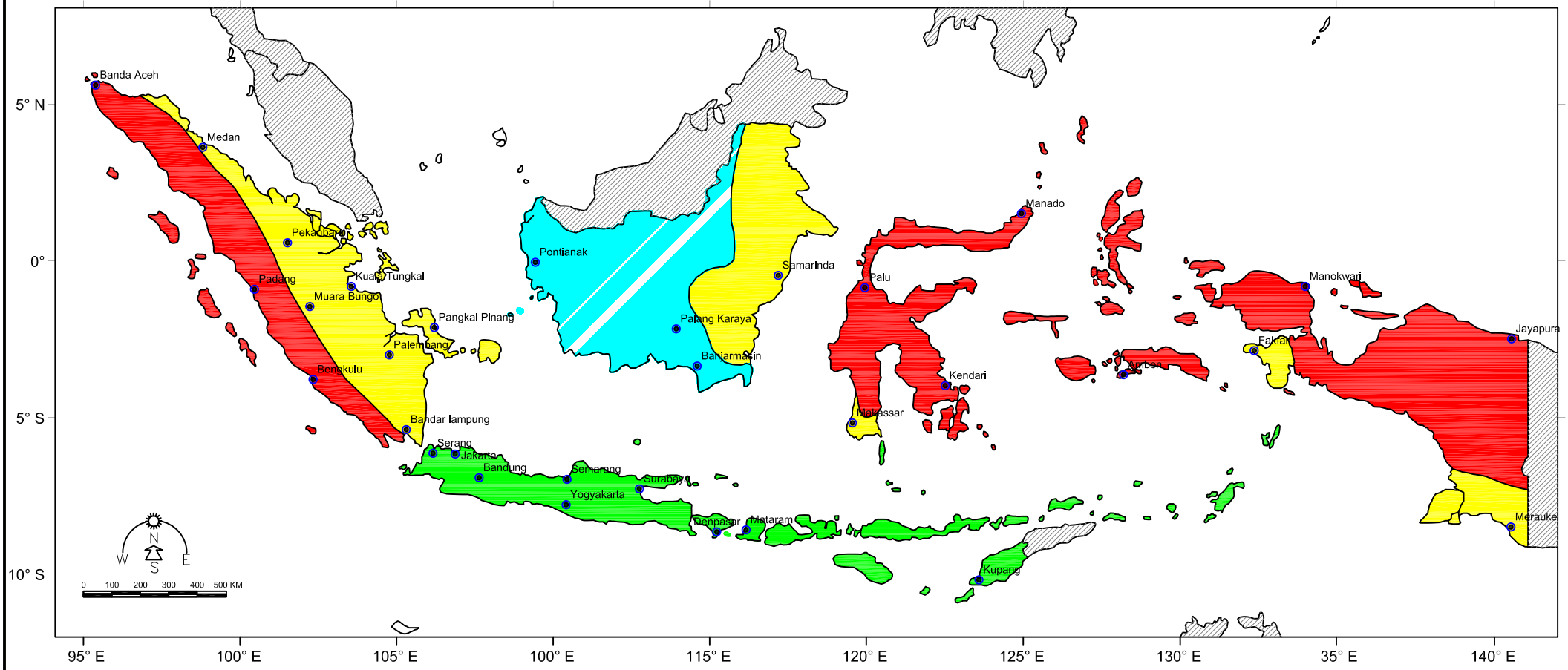
2011

ARCHITECTURE DRAWING

DRAWING LIST OF ARCHITECTURE

DWG No.		DRAWING NAME	SCALE
	AR-01	DRAWING LIST	NTS
	AR-02	ZONATION EARTHQUAKE MAP	NTS
	AR-03	GROUND FLOOR PLAN AND ROOF PLAN	1:200
	AR-04	ELEVATION	1:200
	AR-05	SECTION A-A AND SECTION B-B	1:200
	AR-06	DETAIL OF ROOF TRUSS	1:30
	AR-07	GROUND FLOOR CEILING PLAN	1:200
	AR-08	DOOR AND WINDOW PLAN, FITTING SCHEDULE	1:200

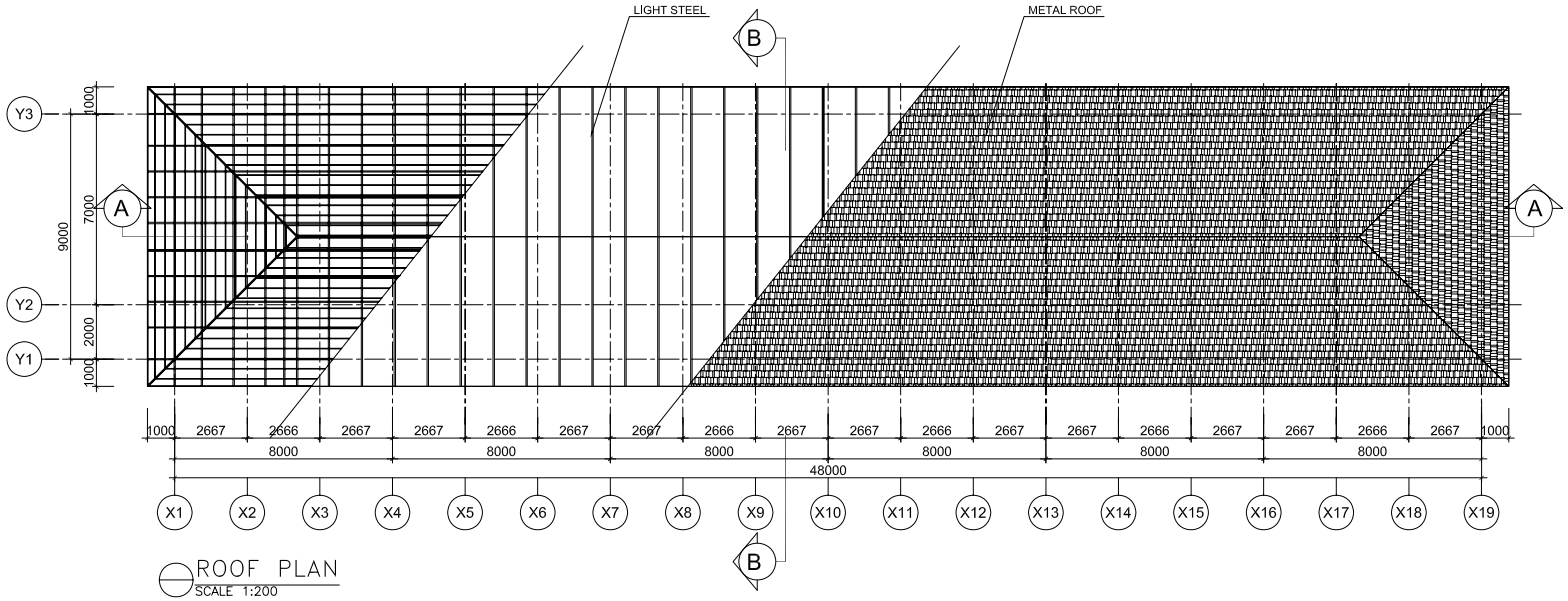
PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY DRAWING LIST	NTS					AR-01



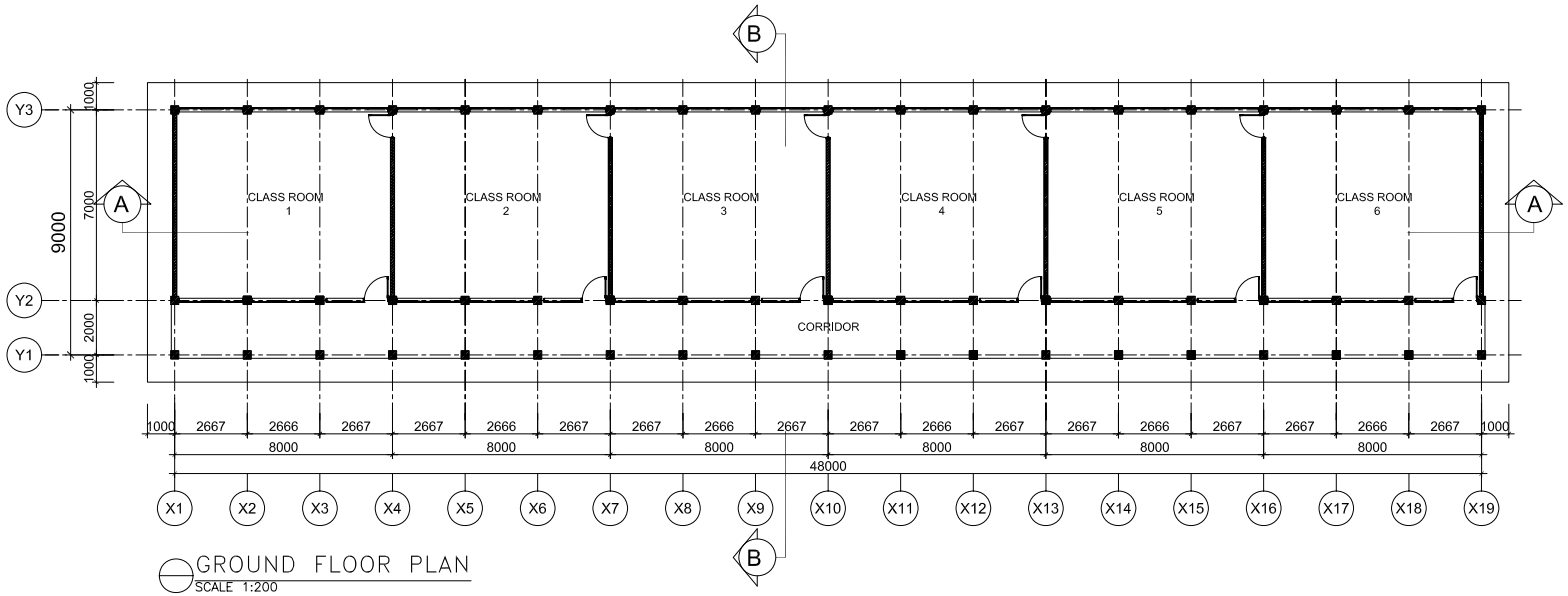
ZONA I ZONA II ZONA III ZONA IV	ZONA I	Banda Aceh Medan Barat Padang Bengkulu Lampung Barat Jambi Barat Palu Kendari Makassar Utara Ambon Manokwari Jayapura Manado	ZONA II	Jakarta Jawa Barat Yogyakarta Jawa Tengah Jawa Timur Denpasar Mataram Kupang Bandung	ZONA III	Samarinda Banjarmasin Makassar Selatan Fakfak Medan Timur Pekanbaru Jambi Palembang Lampung Timur	ZONA IV	Pontianak Palangkaraya Merauke Selatan
Base Shear Coefficien	0.3		0.2		0.1		0.013	

PETA ZONASI GEMPA INDONESIA

PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY ZONATION EARTHQUAKE MAP	NTS					AR-02

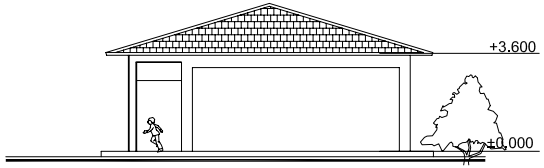


ROOF PLAN
SCALE 1:200

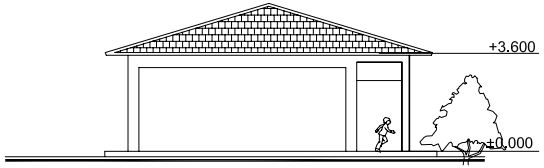


GROUND FLOOR PLAN
SCALE 1:200

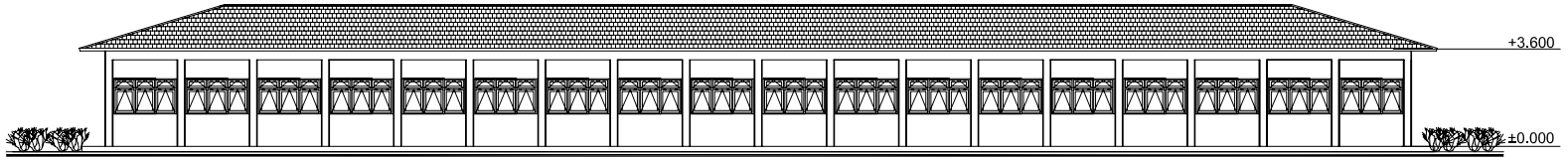
PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY GROUND FLOOR PLAN AND ROOF PLAN	1:200					AR-03



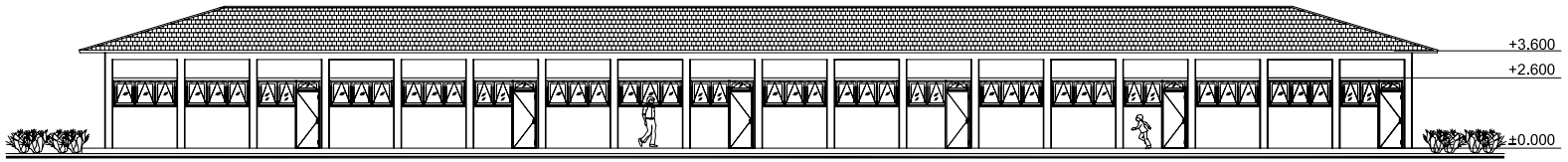
RIGHT SIDE ELEVATION
SCALE 1:200



LEFT SIDE ELEVATION
SCALE 1:200

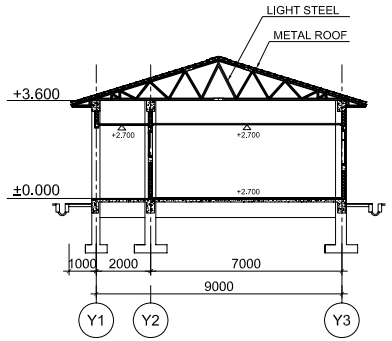


BACK ELEVATION
SCALE 1:200

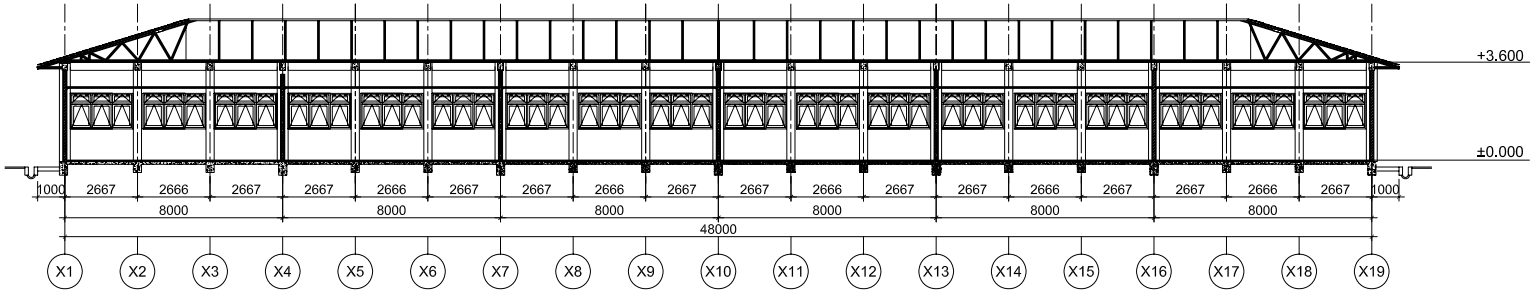


FRONT ELEVATION
SCALE 1:200

PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY ELEVATION	1:200					AR-04

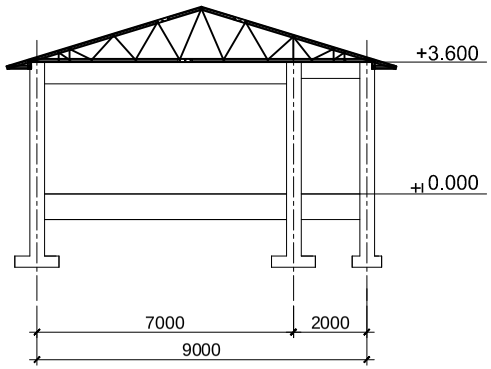


SECTION B–B
SCALE 1:200

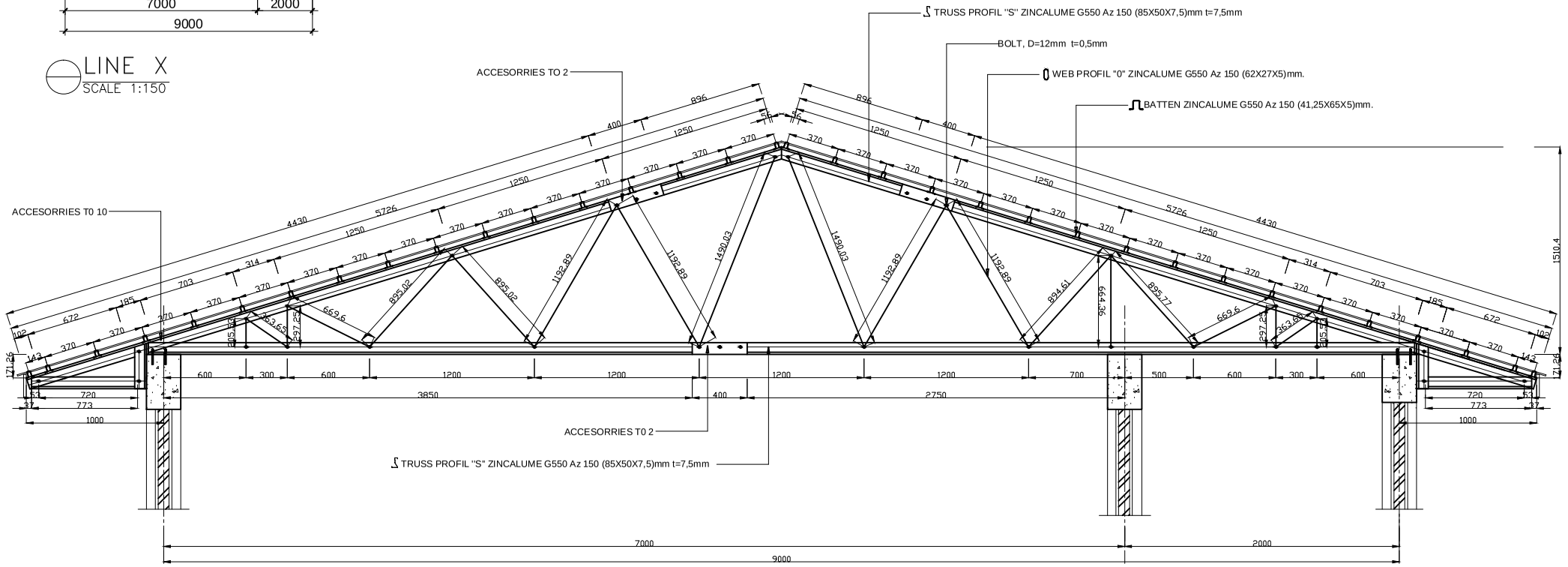


SECTION A–A
SCALE 1:200

PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY SECTION A-A AND SECTION B-B	1:200					AR-05



LINE X
SCALE 1:150



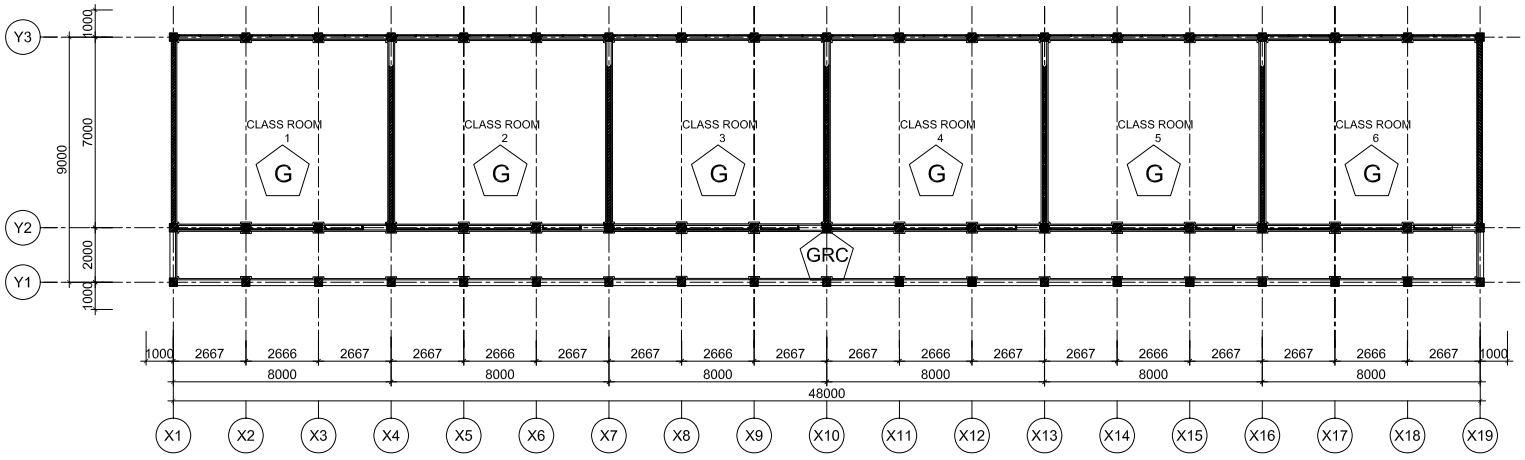
DETAIL OF ROOF TRUSS

SCALE 1:30

PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY DETAIL OF ROOF TRUSS	1:30					AR-06

G GYPSUM BOARD = 9MM

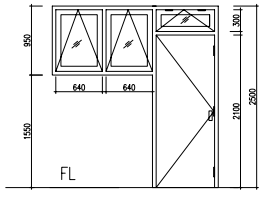
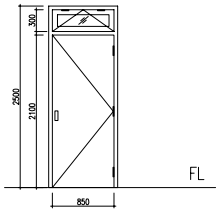
GRC GLASS FIBER REINFORCED CEMENT = 6MM

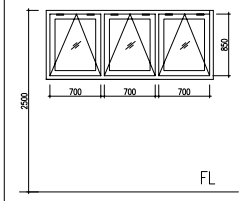
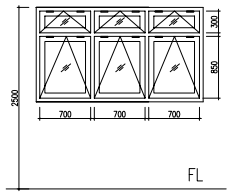


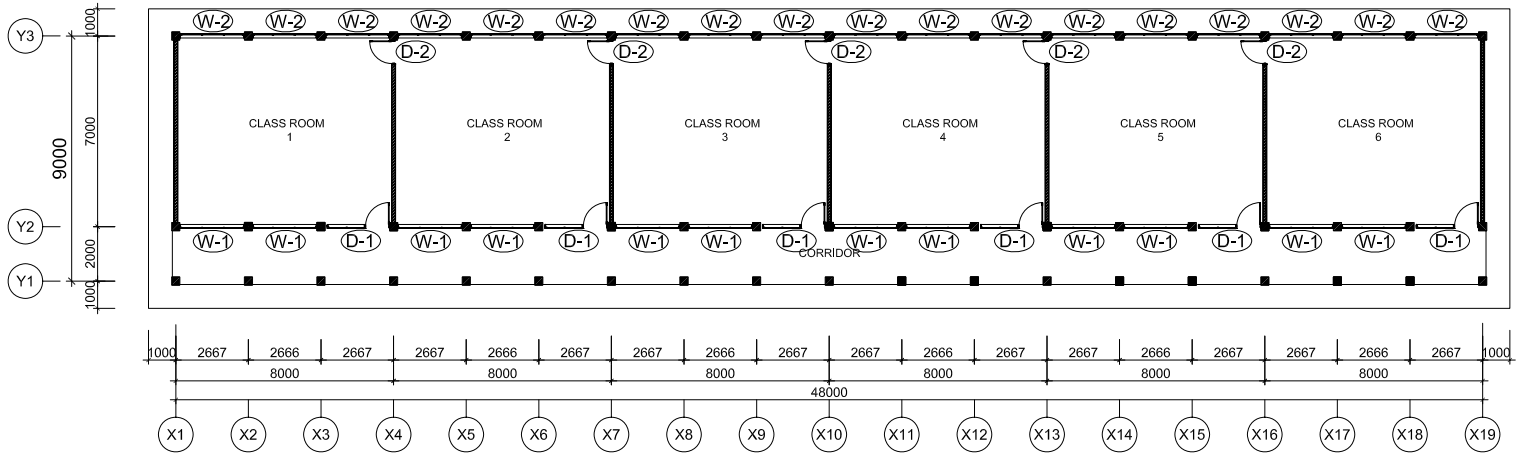
GROUND FLOOR CEILING PLAN
SCALE 1:200

PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY GROUND FLOOR CEILING PLAN	1:200					AR-07

FITTING SCHEDULE

DOOR SCHEDULE			
D1		D2	
			
LOCATION	SEE DRAWING DOOR AND WINDOW PLAN	LOCATION	SEE DRAWING DOOR AND WINDOW PLAN
FRAME MATERIAL	ALUMUNIUM	FRAME MATERIAL	ALUMUNIUM
PANEL MATERIAL	GLASS 5 mm; TEAK PLYWOOD FINISH PAINT	PANEL MATERIAL	GLASS 5 mm; TEAK PLYWOOD FINISH PAINT
ACCESSORIES	HINGES; HANDLE; LOCKCASE	ACCESSORIES	HINGES; HANDLE; LOCKCASE

WINDOW SCHEDULE			
W1		W2	
			
LOCATION	SEE DRAWING DOOR AND WINDOW PLAN	LOCATION	SEE DRAWING DOOR AND WINDOW PLAN
FRAME MATERIAL	ALUMUNIUM	FRAME MATERIAL	ALUMUNIUM
PANEL MATERIAL	GLASS 5 mm	PANEL MATERIAL	GLASS 5 mm
ACCESSORIES	HINGES; SPRING KNIP; WINDOW HOLDER	ACCESSORIES	HINGES; SPRING KNIP; WINDOW HOLDER



DOOR & WINDOW PLAN
SCALE 1:200

PROJECT NAME		TITLE	SCALE	DATE	DESIGNED	CHECKED	APPROVED	DWG No.
PROTOTYPE ELEMENTARY SCHOOL BUILDINGS	MINISTRY OF NATIONAL EDUCATION	QUAKE-RESISTANCE SCHOOL BUILDING ONE-STOREY DOOR & WINDOW PLAN AND FITTING SCHEDULE	1:200					AR-08