Figure 3.2.10   Slope > 20 Degree Area

Source: The JICA Study Team

CUADRO N° 1: TOTAL DE VIVIENDAS POR CONDICIÓN DE OCUPACIÓN Y NÚMERO DE OCUPANTES, SEGÚN CLASE Y TIPO DE VIVIENDA
CENSO 2001

CLASE Y TIPO DE VIVIENDA	TOTAL	CONDICIÓN DE OCUPACIÓN					
		OCUPADA			DESOCUPADA	USO OCASIONAL	EN CONSTRUCCIÓN
		N° DE VIVIENDAS	N° DE OCUPANTES	OCUPANTES POR VIVIENDA			
TOTAL.	491590	446226	1836286	4,1	28926	10603	5835
FAMILIARES	488827	443463	1808982	4,1	28926	10603	5835
QUINTA O CASAQUINTA 1/.	14191	12119	50383	4,2	638	1141	293
CASA.	226772	209610	939113	4,5	11148	2842	3172
APARTAMENTO EN EDIFICIO	217608	193565	700546	3,6	15576	6225	2242
APARTAMENTO EN QUINTA, CASAQUINTA O CASA	13029	11947	46101	3,9	762	192	128
CASA DE VECINDAD.	39	39	799	20,5	–	–	–
RANCHO.	16501	15496	69697	4,5	802	203	–
OTRA CLASE 2/	687	687	2343	3,4	–	–	–
COLECTIVAS	2763	2763	27304	9,9	–	–	–

CUADRO N° 1: TOTAL DE VIVIENDAS POR CONDICIÓN DE OCUPACIÓN Y NÚMERO DE OCUPANTES, SEGÚN CLASE Y TIPO DE VIVIENDA
CENSO 2001

CLASE Y TIPO DE VIVIENDA	TOTAL	CONDICIÓN DE OCUPACIÓN					
		OCUPADA			DESOCUPADA	USO OCASIONAL	EN CONSTRUCCIÓN
		N° DE VIVIENDAS	N° DE OCUPANTES	OCUPANTES POR VIVIENDA			
Municipio SUCRE.	153424	134346	546766	4,1	12217	3248	3613
FAMILIARES	153285	134207	545339	4,1	12217	3248	3613
QUINTA O CASAQUINTA 1/.	10906	9266	38641	4,2	550	579	511
CASA.	74663	68033	302620	4,4	4592	514	1524
APARTAMENTO EN EDIFICIO	55678	45786	157288	3,4	6353	2001	1538
APARTAMENTO EN QUINTA, CASAQUINTA O CASA	5196	4811	18749	3,9	280	65	40
CASA DE VECINDAD.	13	13	285	21,9	–	–	–
RANCHO.	6597	6066	27010	4,5	442	89	–
OTRA CLASE 2/	232	232	746	3,2	–	–	–
COLECTIVAS	139	139	1427	10,3	–	–	–

1/ INCLUYE LAS VIVIENDAS CLASIFICADAS COMO MANSIÓN

CLASE Y TIPO DE VIVIENDA	TOTAL	CONDICIÓN DE OCUPACIÓN					
Municipio CHACAO	27191	20099	64629	3,2	4388	1587	1117
FAMILIARES	27090	19998	63693	3,2	4388	1587	1117
QUINTA O CASAQUINTA 1/.	2353	1899	8148	4,3	221	99	134
CASA.	1686	1268	6249	4,9	380	18	20
APARTAMENTO EN EDIFICIO	22638	16504	48219	2,9	3714	1459	961
APARTAMENTO EN QUINTA, CASAQUINTA O CASA	367	281	932	3,3	73	11	2
CASA DE VECINDAD.	–	–	–	–	–	–	–
RANCHO.	9	9	39	4,3	–	–	–
OTRA CLASE 2/	37	37	106	2,9	–	–	–
COLECTIVAS	101	101	936	9,3	–	–	–

1/ INCLUYE LAS VIVIENDAS CLASIFICADAS COMO MANSIÓN

Source: Census 2001, INA

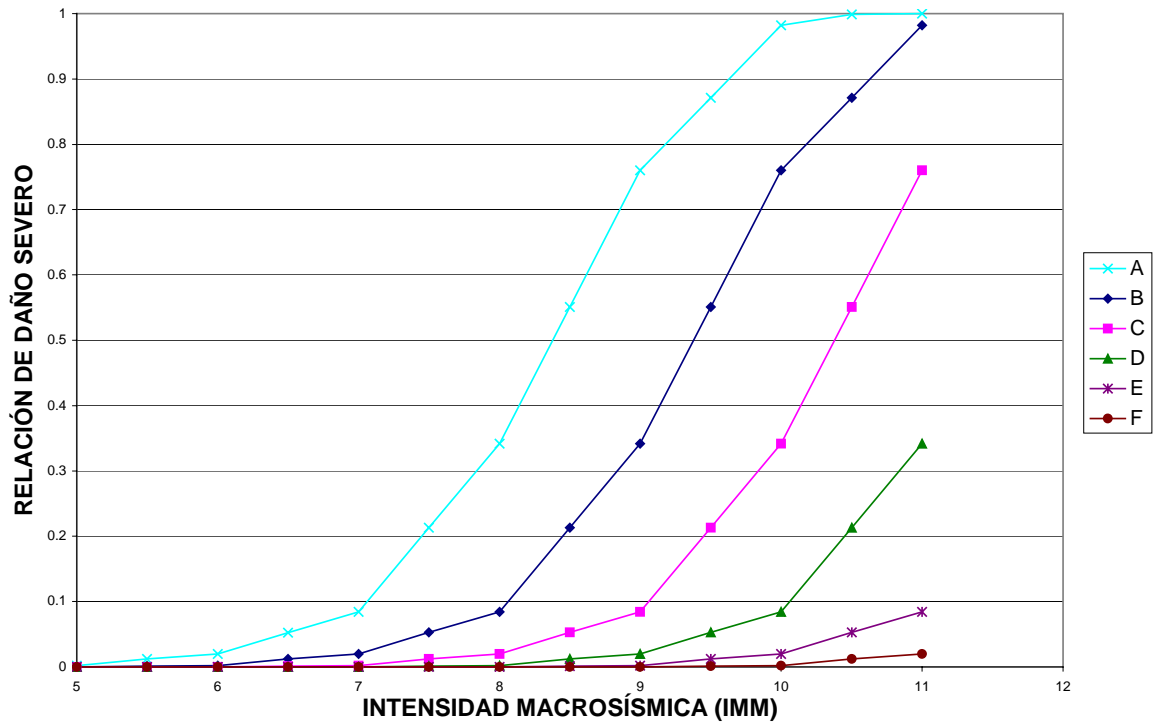**Figure 3.2.11   Census Data of Person / Family**

Figure 3.2.12   The Damage Function for Damage Level 4 / EMS-98

Figure 3.2.13   Vulnerability Classes in EMS-98
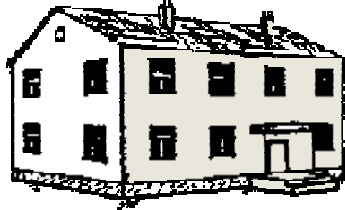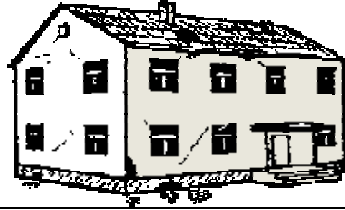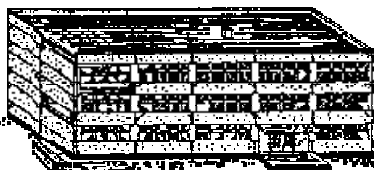
Classification of Damage		
	Masonry	**RC Building**
Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)	Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases. 	Fine cracks in plaster over frame members or in walls at the base. Fine cracks in partitions and infills
Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)	Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys. 	Cracks in columns and beams of frames and in structural walls. Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels.
Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)	Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls). 	Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of concrete cover, buckling of reinforced rods. Large cracks in partition and infill walls, failure of individual infill panels.
Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)	Serious failure of walls; partial structural failure of roofs and floors 	Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns. Collapse of a few columns or of a single upper floor.
Grade 5: Destruction (very heavy structural damage)	Total or near total collapse 	Collapse of ground floor or parts (e. g. wings) of buildings.

Figure 3.2.14   The Classification of Damage Proposed by European Macro-Seismic Scale
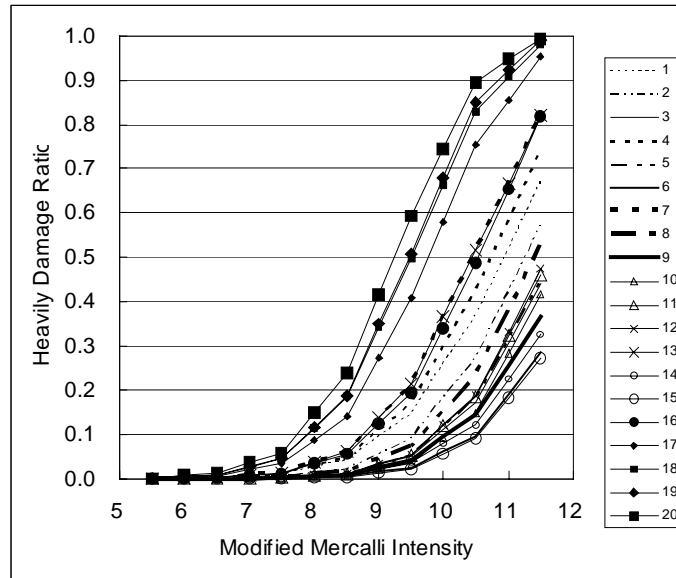
Figure 3.2.15   Building Damage Function Used in this Study

Safina, 2003

Evaluation of existing human damage data in Venezuela

Precious but very little data of the past two Earthquakes in Venezuela, i.e., Caracas (1967) and Cariaco (1997), should be used for validation of local characteristics.

⬇

Evaluation of existing human damage data out of Venezuela

The detailed data of the Quindio Earthquake (Colombia, 1999) was studied.
The correlation of the Quindio Earthquake can be basically applied to low-rise buildings in the study area, though the correlation is difficult to be applied to middle & high-rise buildings

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⬇

Study on the summary of worldwide death damage

The data of Caracas (1967), Mexico (1984), Armenia (1986) earthquakes, of which damage was mainly caused by damage of high buildings, are considered.
The proposed damage function of death for low-rise buildings is compared with the data of the Cariaco (1997) and other earthquakes in the world.
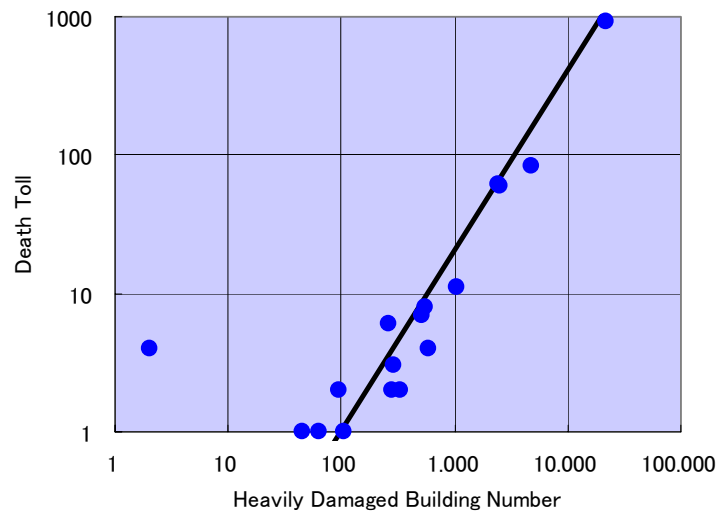
Source: JICA Study Team

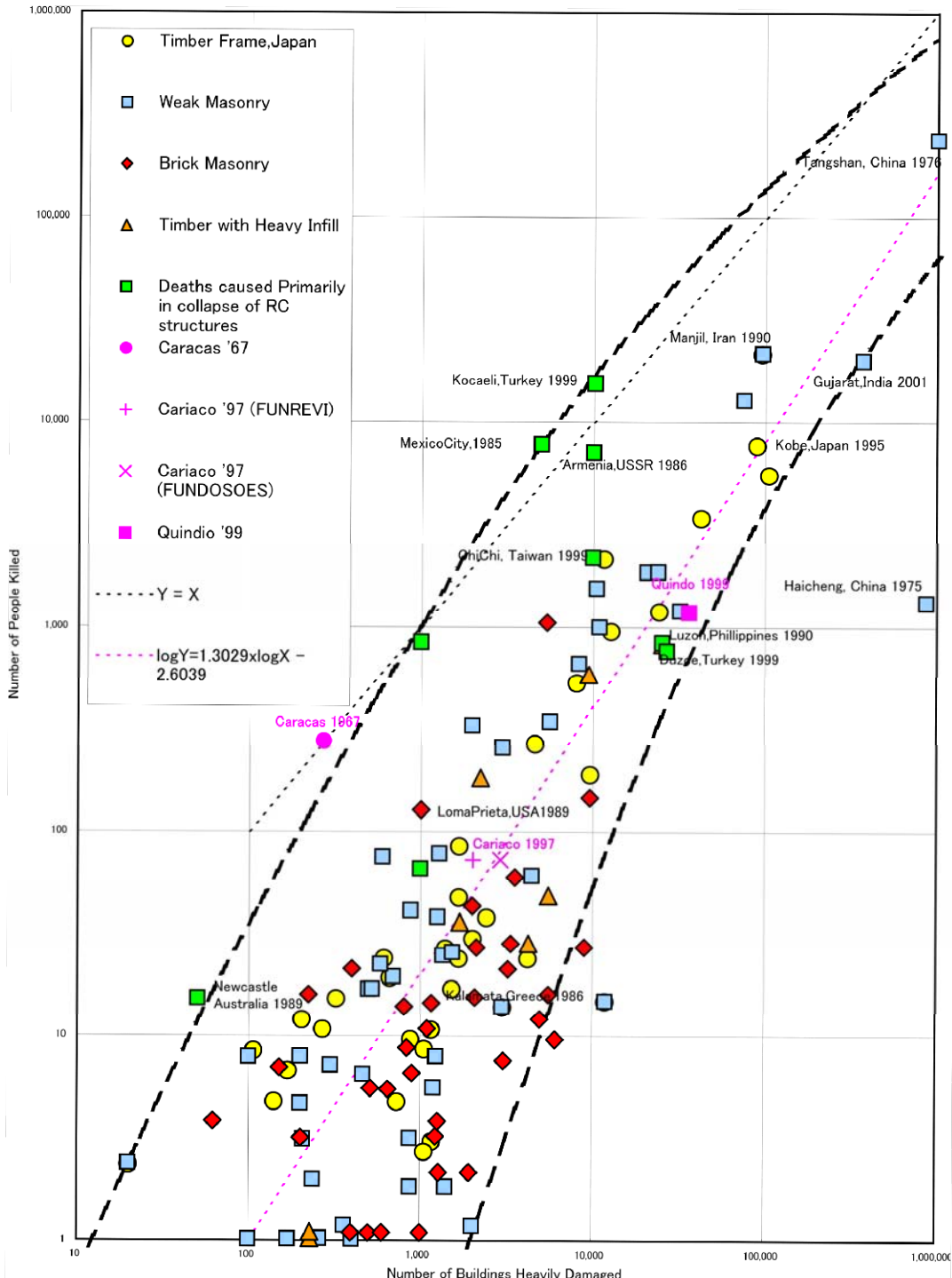**Figure 3.2.16   Flowchart of Human Casualties' Estimation**
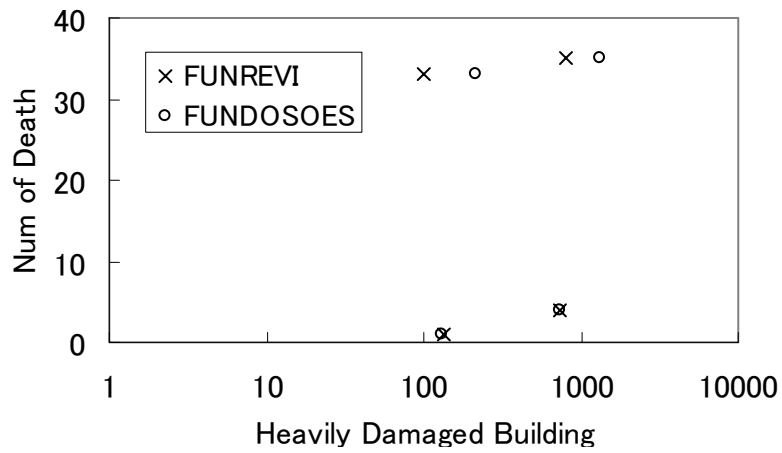
Figure 3.2.17   Relation Between Number of Heavily Damaged Building and Number of Death of Cariaco Earthquake (1997)

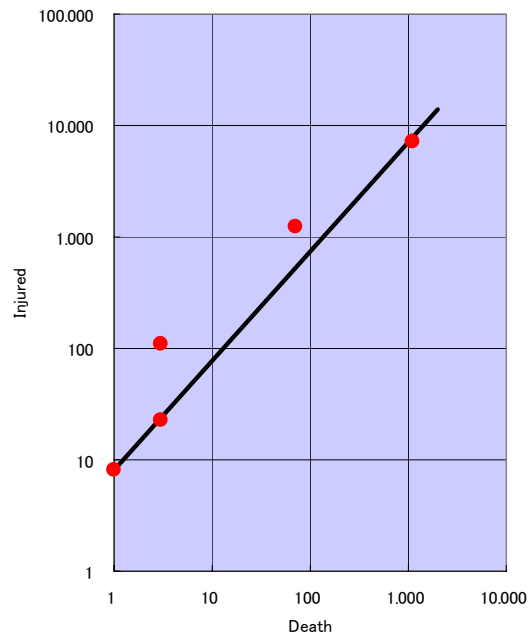**Figure 3.2.18   Relation Between Heavily Damaged Building and Death Toll of Quindio Earthquake (1999, Colombia)**

Relationship between total casualty figures and total building damage statistics
(retouched to Coburn & Spence 1992)

Source: The JICA Study Team

Figure 3.2.19   The Summary of the World Data

Figure 3.2.20   Relationship Between Death and Injured of Quindio Earthquake (1999, Colombia)

ATC-21/ (NEHRP Map Areas 5,6,7 High)

Rapid Visual Screening of Seismically Hazardous Buildings

(hand-drawn sketches with notes:)
EL
CALLE
AV. PPAL. DE LA URBINA
20 MTS
20 mts
1ST Floor
20 MTS
Shear wall made of Bricks
Scale: 2nd FL

Address LA URBINA
Zip
Other Identifiers
No. Stories 2   Year Built 1990
Inspector   Date
Total Floor Area (sq. ft)
Building Name BOMBEROS DE LA URBINA
Use BOMBEROS
(Peel-off label)

OCCUPANCY		STRUCTURAL SCORES AND MODIFIERS												
		BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Residential	No. Persons	Basic Score	4.5	4.5	3.0	5.5	3.5	2.0	3.0	1.5	2.0	1.5	3.0	1.0
Commercial	0–10	High Rise	N/A	-2.0	-1.0	N/A	-1.0	-1.0	-1.0	-0.5	N/A	-0.5	-1.0	-0.5
Office	11–100	Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Industrial	100+	Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-0.5	-0.5	-1.0	-1.0	-0.5	-0.5
Pub. Assem.		Soft Story	-1.0	-2.5	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-2.0	-2.0	-1.0
School		Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Govt. Bldg.		Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Emer. Serv.		Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Historic Bldg.		Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
		Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Non Structural Falling Hazard ☐		Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
DATA CONFIDENCE		SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
		SL3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
* = Estimated, Subjective, or Unreliable Data		SL3 & 8 to 20 stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8
DNK = Do Not Know		FINAL SCORE	4.5											

COMMENTS Torsion will get curling Earthquake. The base of all columns is pin joint wit 6-Anchor.bolts. 1st Floor Height is Very large. Compare with 2nd floor height.

ATC6/54 30052.01

Detailed Evaluation Required?
YES (NO)

Figure 4-1a Data collection form

54   *RSP Method and the Data Collection Form*   *ATC-21*

Source: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook FEMA 154 1968

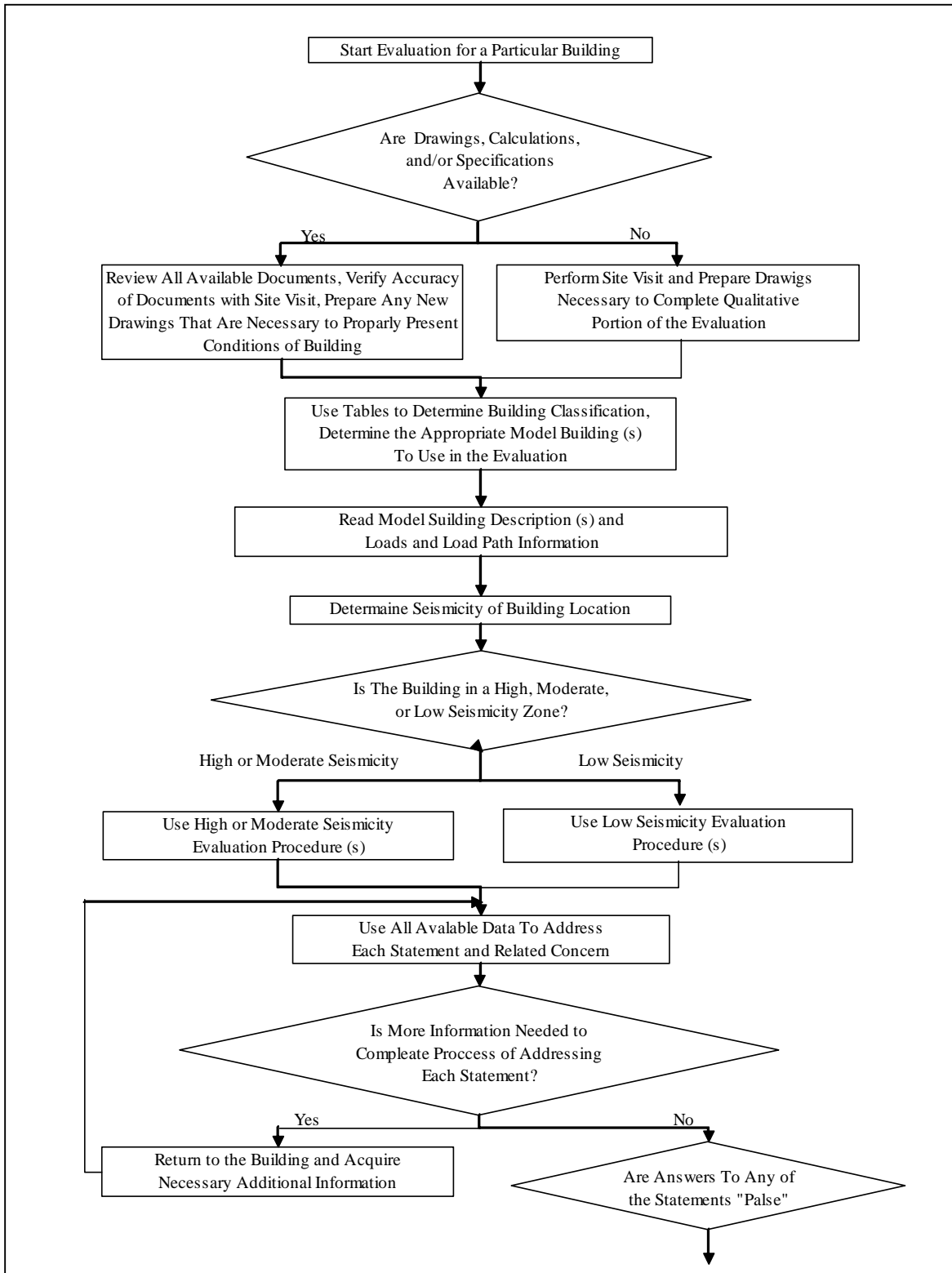**Figure 3.3.1   The Scoring Sheet with Actual Record**
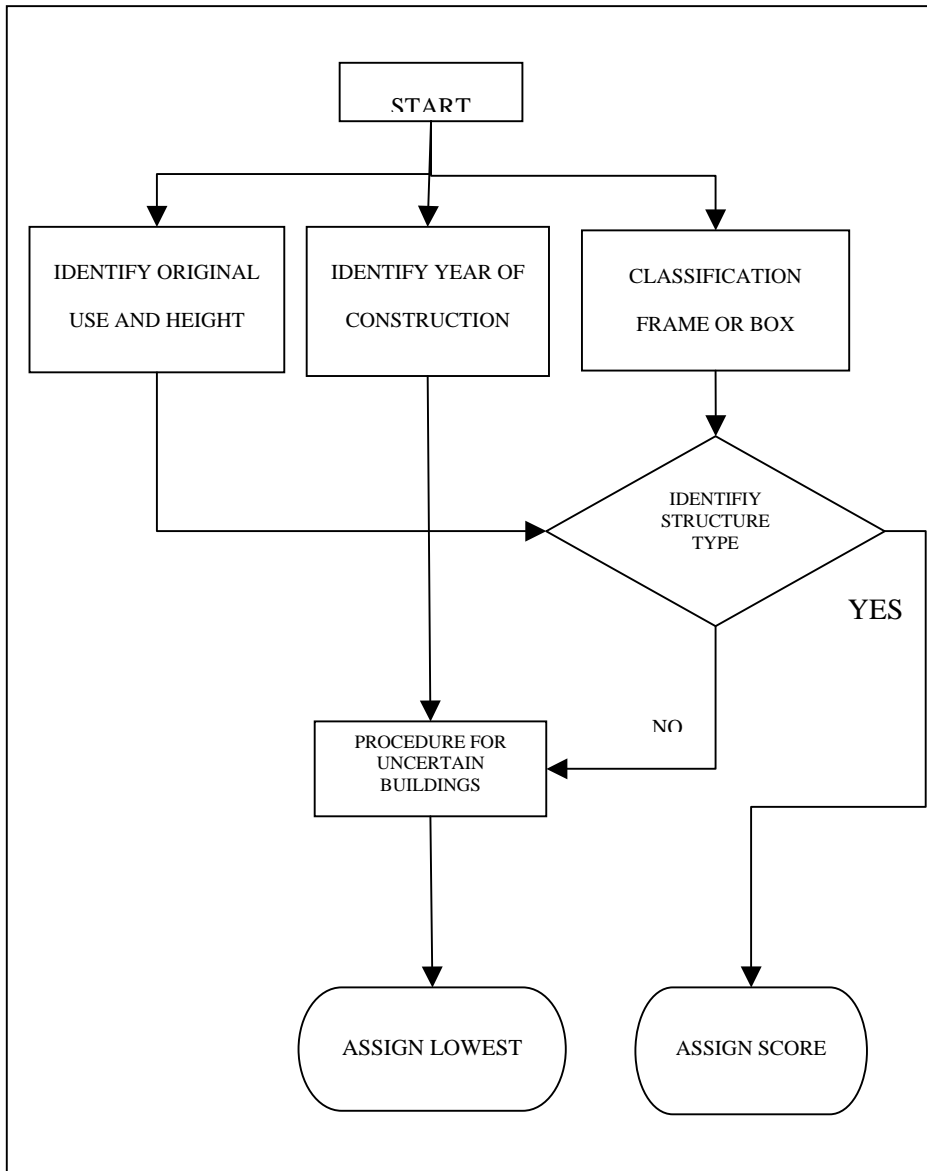
Source: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook FEMA 154

**Figure 3.3.2   Work Flowchart for the Rapid Screening Procedure (RSP)
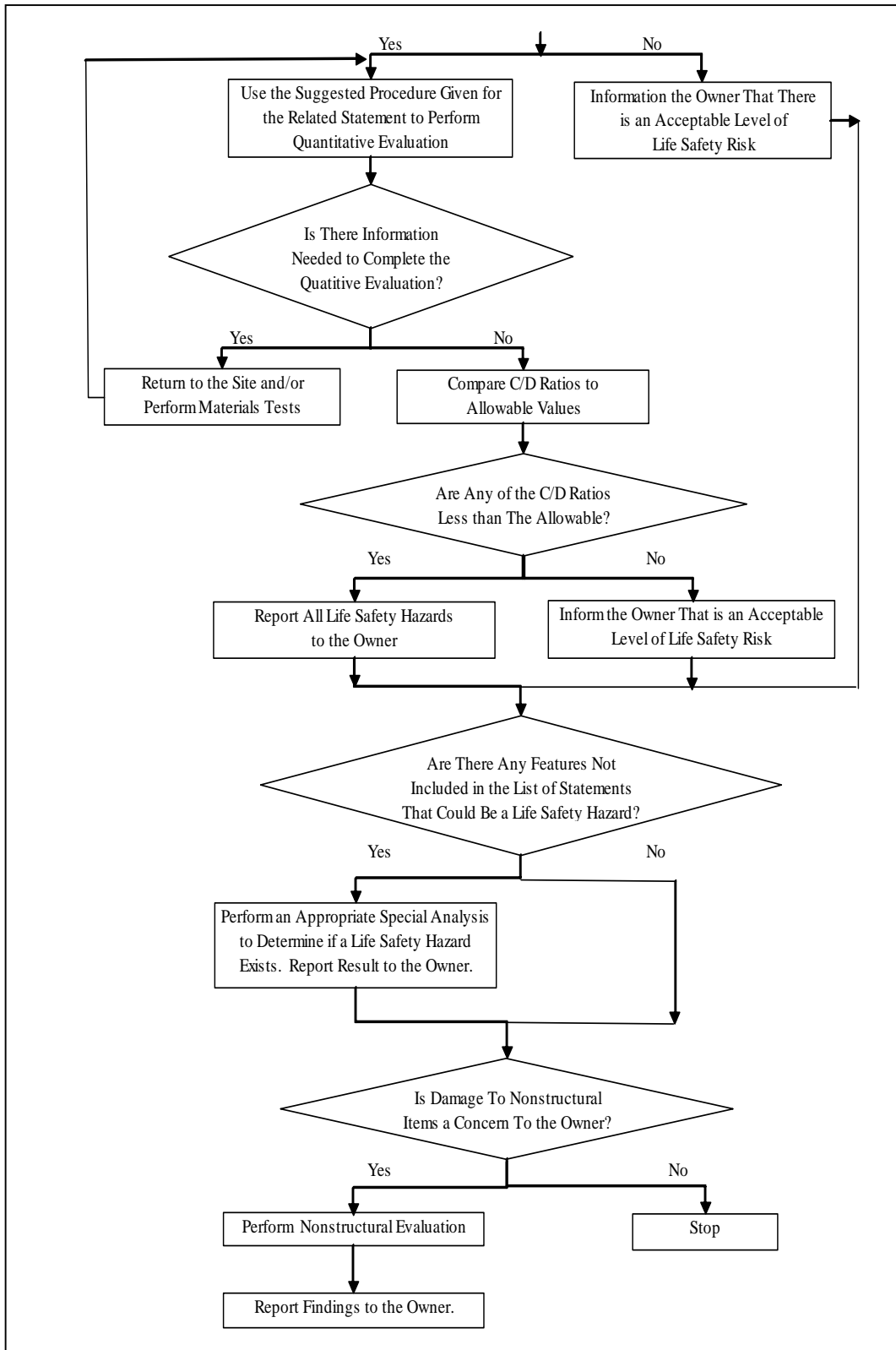Identification Procedure**
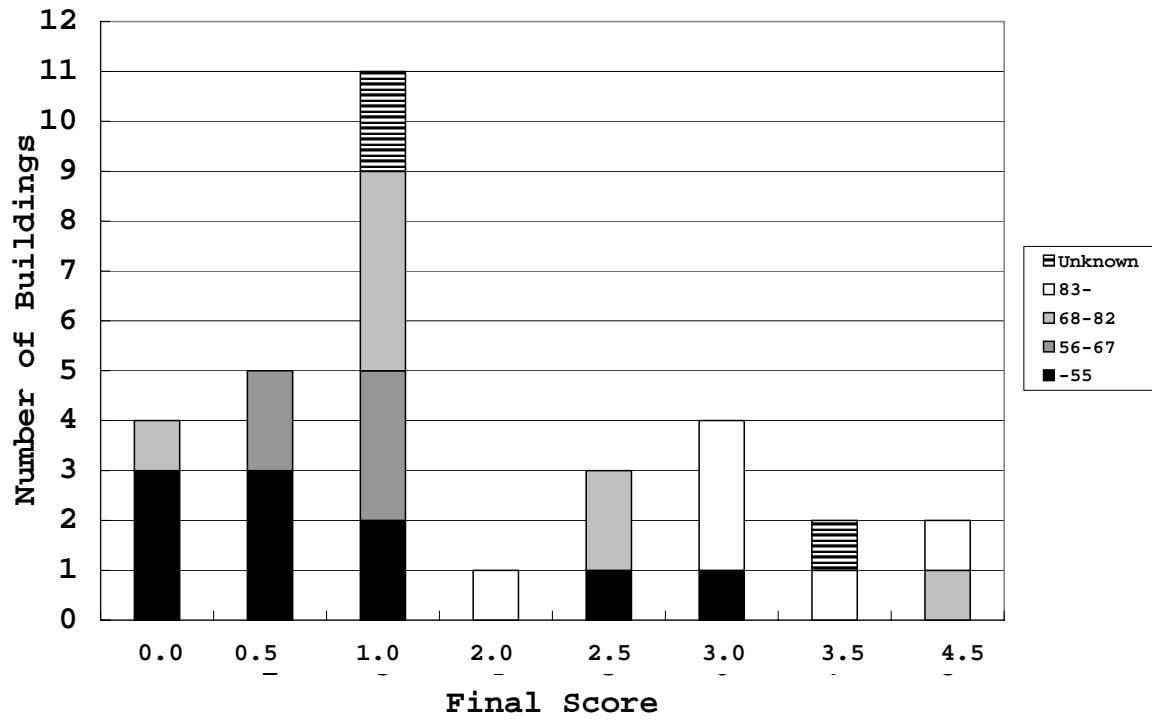
Source: The JICA Study Team

Figure 3.3.3　Result of RVS: Relation of Built Year and Final Score

Source: Evaluating The Seismic Resistance Of Existing Buildings; ATC 14   1987

Figure 3.3.4   Seismic Evaluation Procedure (Continued on Next Page)

```
                              Yes              ↓            No
         ┌─────────────────────────────┐      ┌─────────────────────────────┐
         │ Use the Suggested Procedure │      │ Information the Owner That   │
         │ Given for the Related       │      │ There is an Acceptable Level │
         │ Statement to Perform        │      │ of Life Safety Risk          │
         │ Quantitative Evaluation     │      └─────────────────────────────┘
         └─────────────────────────────┘

                    ◇ Is There Information
                      Needed to Complete the
                      Quatitive Evaluation?

              Yes                        No
    ┌─────────────────────┐     ┌─────────────────────┐
    │ Return to the Site  │     │ Compare C/D Ratios  │
    │ and/or Perform      │     │ to Allowable Values │
    │ Materials Tests     │     └─────────────────────┘
    └─────────────────────┘

                    ◇ Are Any of the C/D Ratios
                      Less than The Allowable?

              Yes                        No
    ┌─────────────────────┐     ┌─────────────────────┐
    │ Report All Life     │     │ Inform the Owner    │
    │ Safety Hazards      │     │ That is an          │
    │ to the Owner        │     │ Acceptable Level of │
    └─────────────────────┘     │ Life Safety Risk    │
                                └─────────────────────┘

                    ◇ Are There Any Features Not
                      Included in the List of Statements
                      That Could Be a Life Safety Hazard?

              Yes                        No
    ┌─────────────────────┐
    │ Perform an          │
    │ Appropriate Special │
    │ Analysis to         │
    │ Determine if a Life │
    │ Safety Hazard       │
    │ Exists. Report      │
    │ Result to the Owner.│
    └─────────────────────┘

                    ◇ Is Damage To Nonstructural
                      Items a Concern To the Owner?

              Yes                        No
    ┌─────────────────────┐     ┌─────────────────────┐
    │ Perform             │     │ Stop                │
    │ Nonstructural       │     └─────────────────────┘
    │ Evaluation          │
    └─────────────────────┘

    ┌─────────────────────┐
    │ Report Findings to  │
    │ the Owner.          │
    └─────────────────────┘
```

Source: Evaluating The Seismic Resistance Of Existing Buildings; ATC 14   1987

Figure 3.3.5   Seismic Evaluation Procedure (Continued from Previous Page)
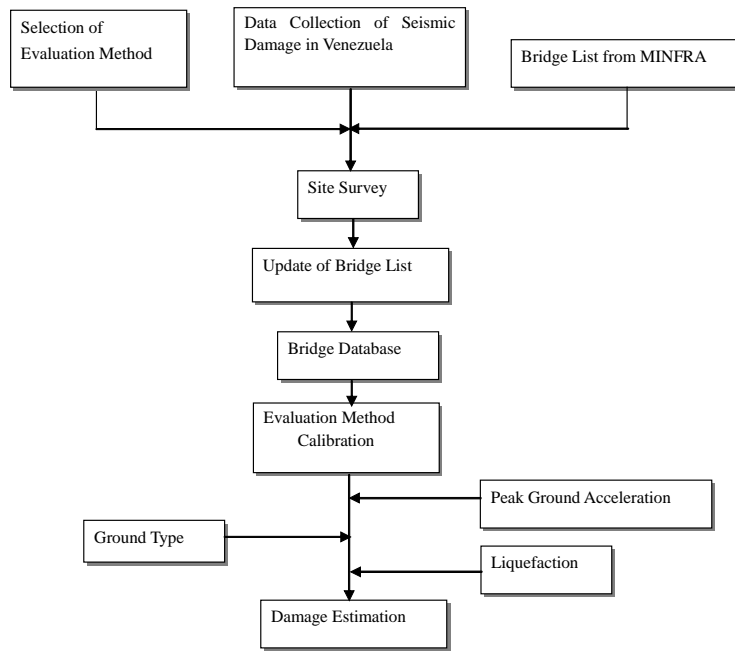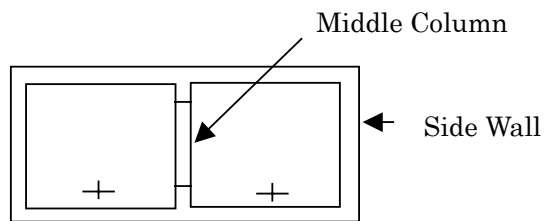
Figure 3.4.1   Procedure of Seismic Damage Estimation
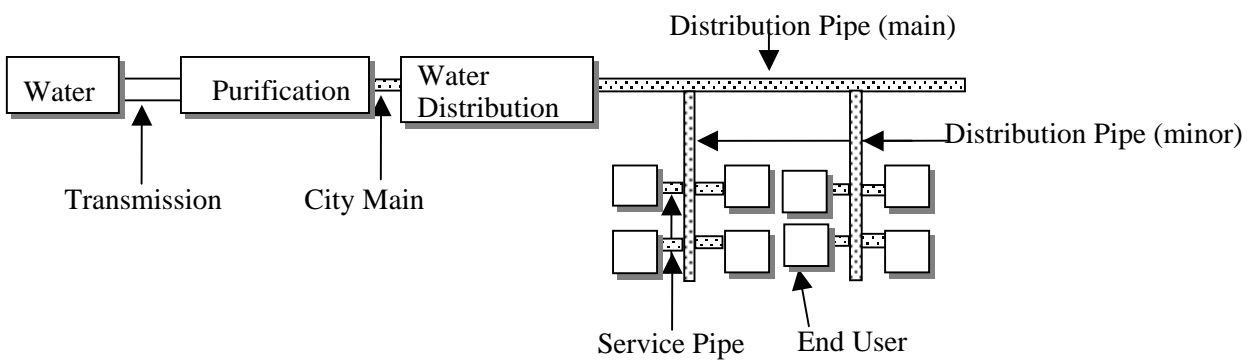

Figure 3.4.2   Cut and Cover Type Tunnel

Figure 3.4.3   Water Supply System

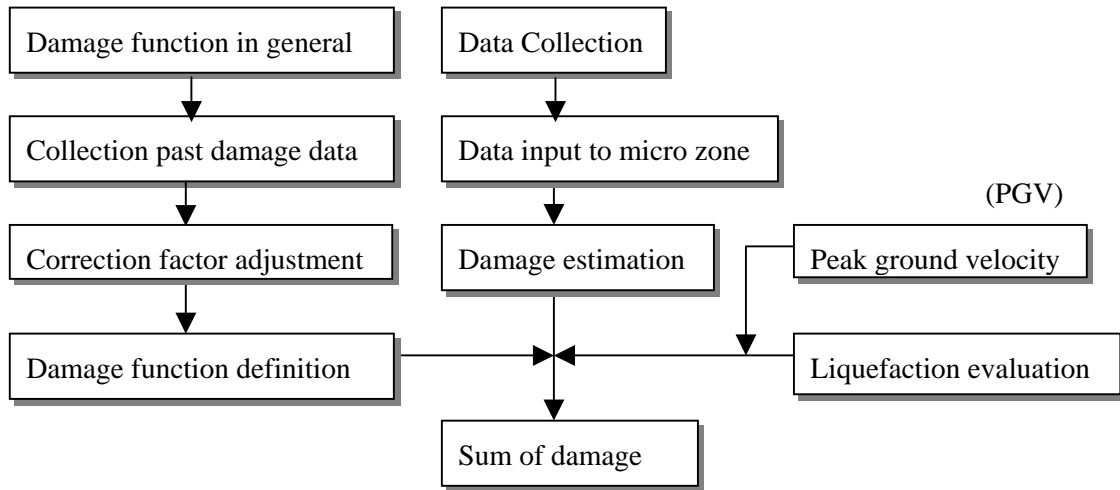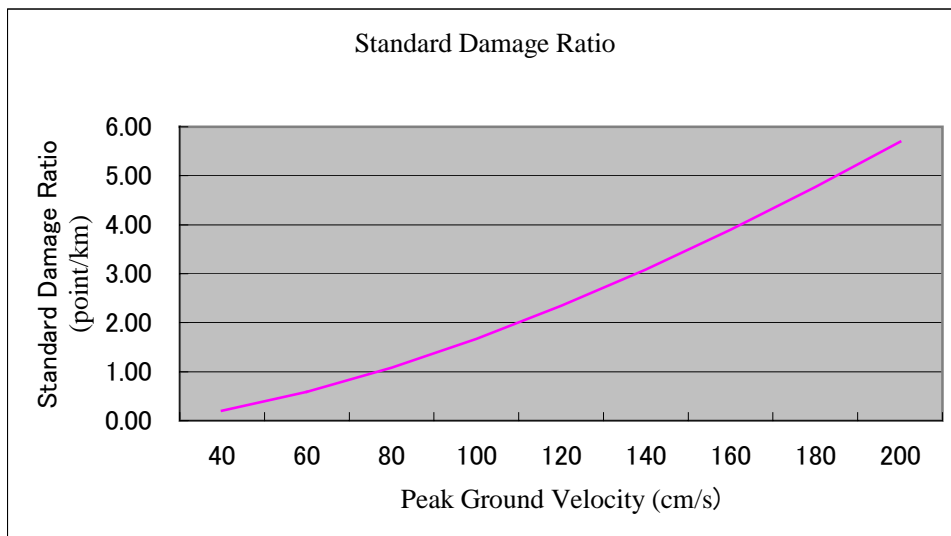**Figure 3.4.4   Flow Chart of Damage Estimation for Water Supply**

Figure 3.4.5   Standard Damage Ratio
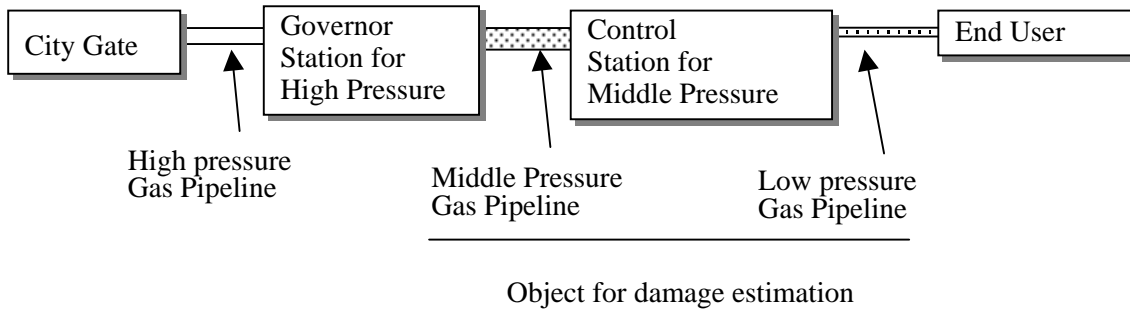
Object for damage estimation
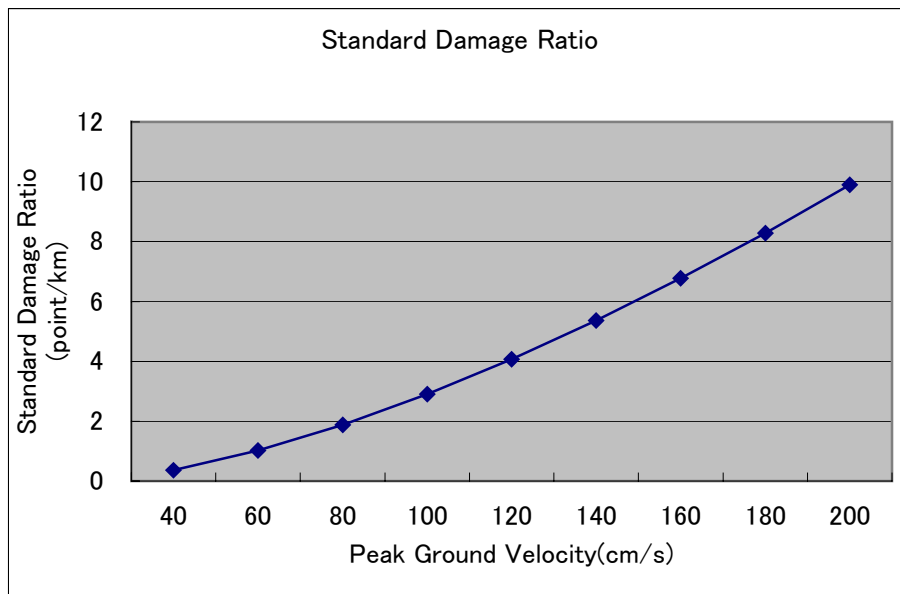
Figure 3.4.6   Natural Gas Pipeline Network

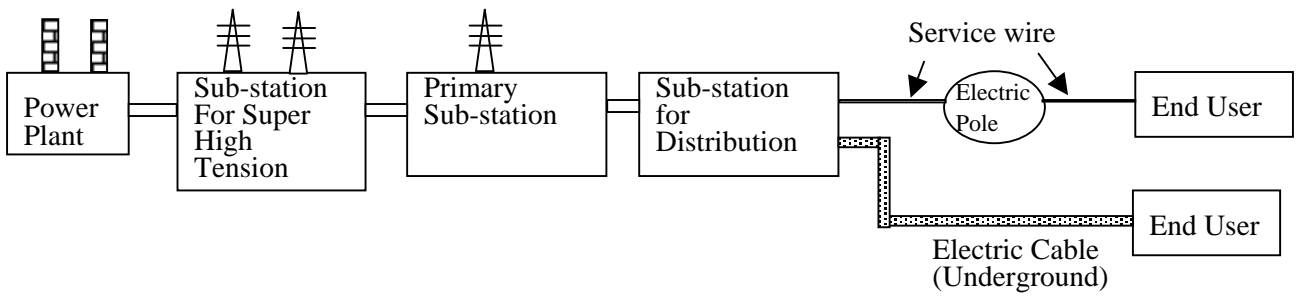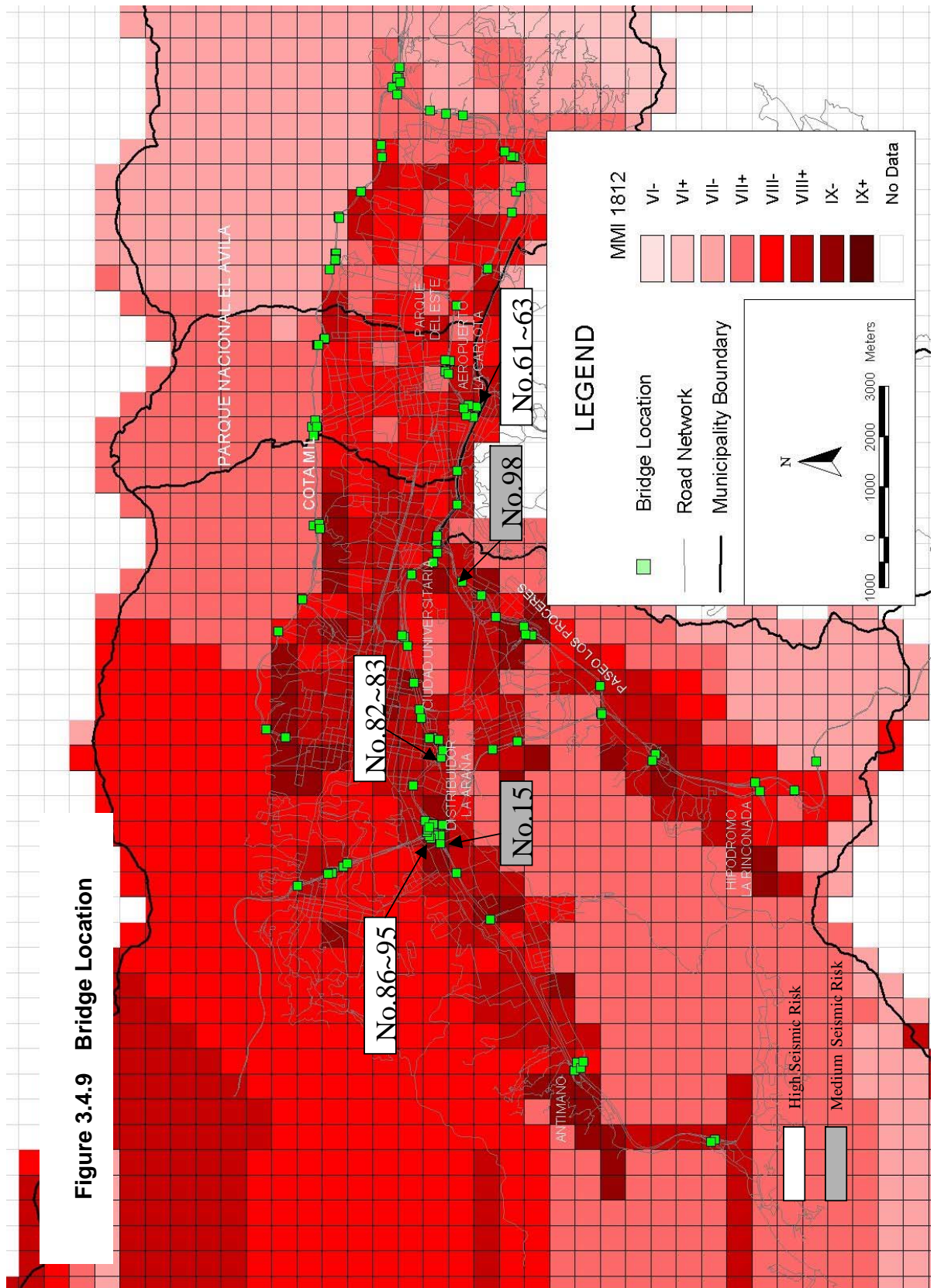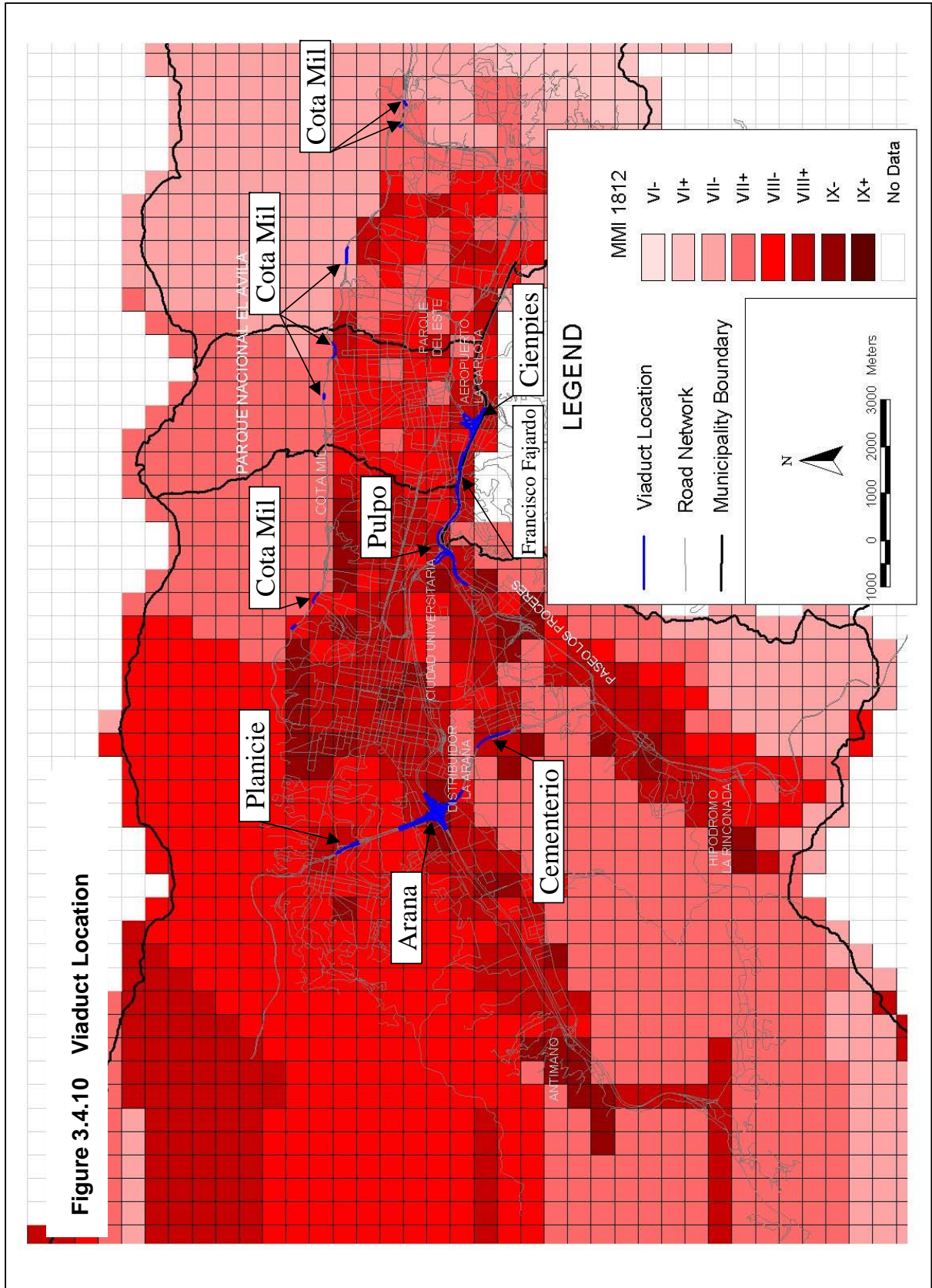**Figure 3.4.7   Standard Damage Ratio for Gas Pipeline**

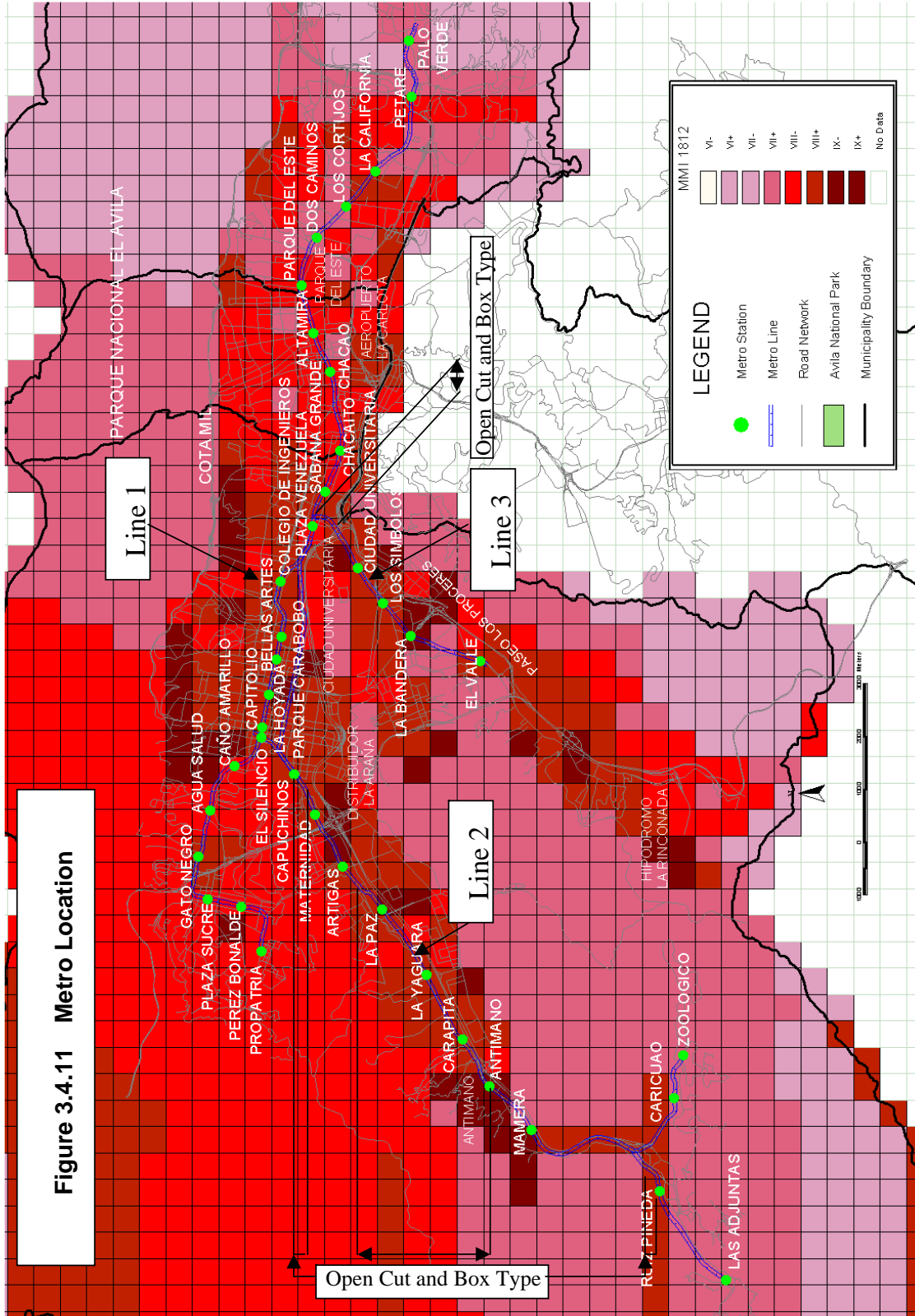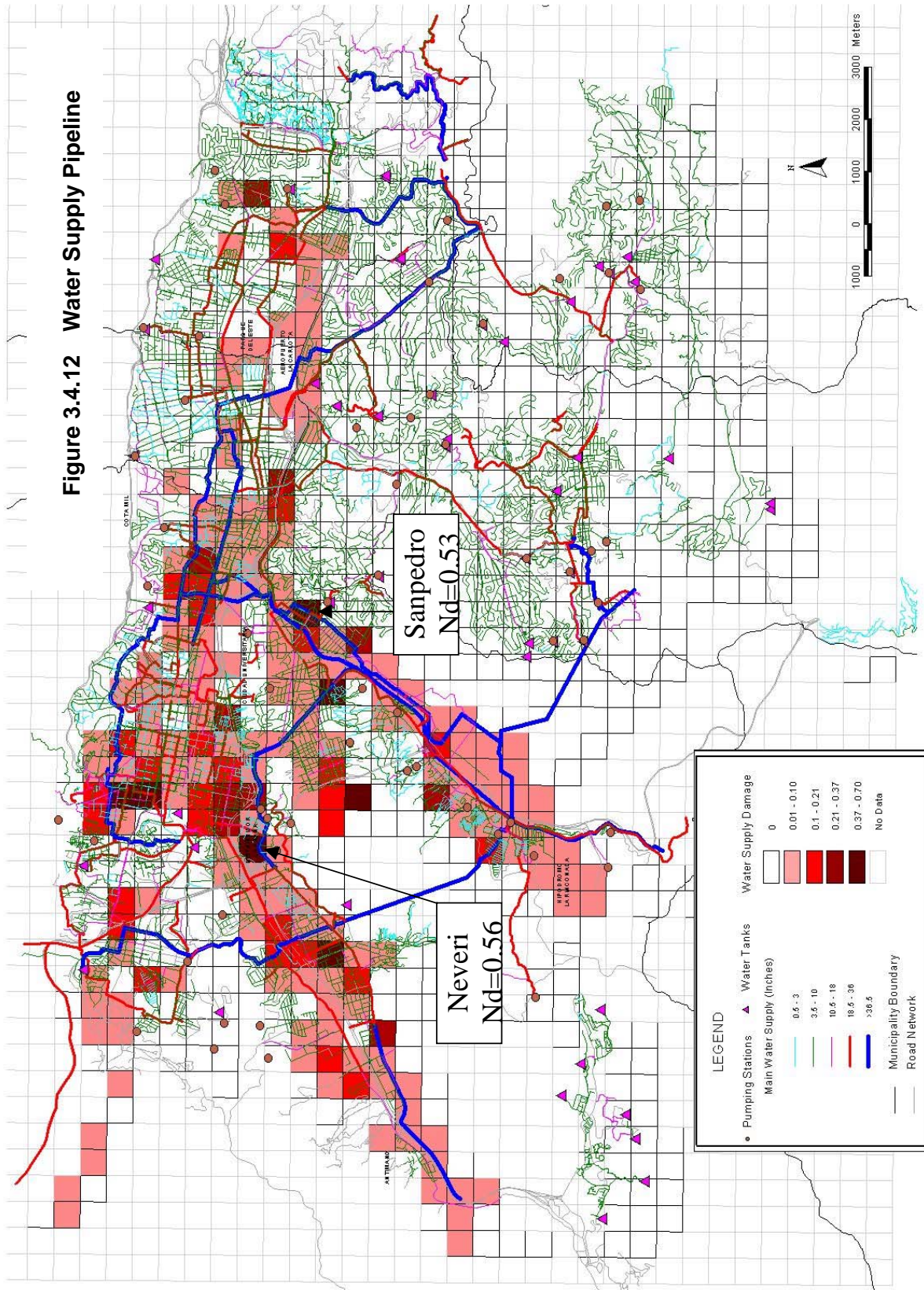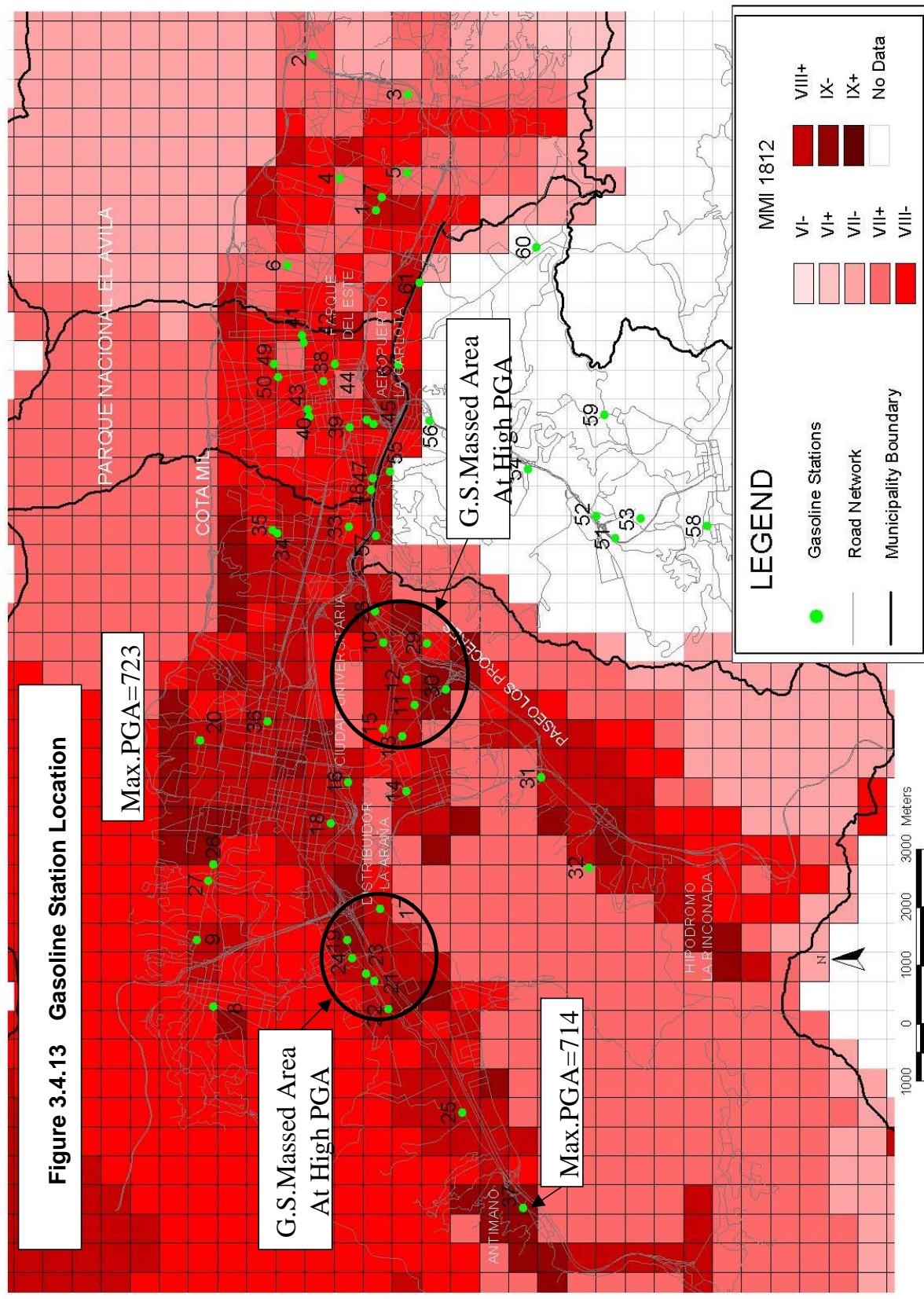**Figure 3.4.8   Electric Power Supply Network**

Figure 3.4.9 Bridge Location

No.61~63

No.98

No.82~83

No.15

No.86~95

LEGEND

Bridge Location

Road Network

Municipality Boundary

MMI 1812

VI-
VI+
VII-
VII+
VIII-
VIII+
IX-
IX+
No Data

N

0   1000   2000   3000   Meters

1000

High Seismic Risk

Medium Seismic Risk

PARQUE NACIONAL EL AVILA

COTA MIL

PARQUE DEL ESTE

AEROPUERTO LA CARLOTA

CIUDAD UNIVERSITARIA

PASEO LOS PROCERES

DISTRIBUIDOR LA ARAÑA

HIPODROMO LA RINCONADA

ANTIMANO

Figure 3.4.10 Viaduct Location

Cota Mil

Cota Mil

Cota Mil

Cota Mil

Pulpo

Cienpies

Francisco Fajardo

Planicie

Arana

Cementerio

PARQUE NACIONAL EL AVILA

PARQUE DEL ESTE

AEROPUERTO LA CARLOTA

COTA MIL

CIUDAD UNIVERSITARIA

DISTRIBUIDOR LA ARAÑA

PASEO LOS PROCERES

ANTIMANO

HIPODROMO LA RINCONADA

LEGEND

MMI 1812
VI-
VI+
VII-
VII+
VIII-
VIII+
IX-
IX+
No Data

Viaduct Location
Road Network
Municipality Boundary

N

1000   0   1000   2000   3000   Meters

Figure 3.4.11　Metro Location

Figure 3.4.12 Water Supply Pipeline

LEGEND

Pumping Stations
Water Tanks
Main Water Supply (Inches)
0.5 - 3
3.5 - 10
10.5 - 18
18.5 - 36
>36.5
Municipality Boundary
Road Network

Water Supply Damage
0
0.01 - 0.10
0.1 - 0.21
0.21 - 0.37
0.37 - 0.70
No Data

Sanpedro
Nd=0.53

Neveri
Nd=0.56

Figure 3.4.13　Gasoline Station Location
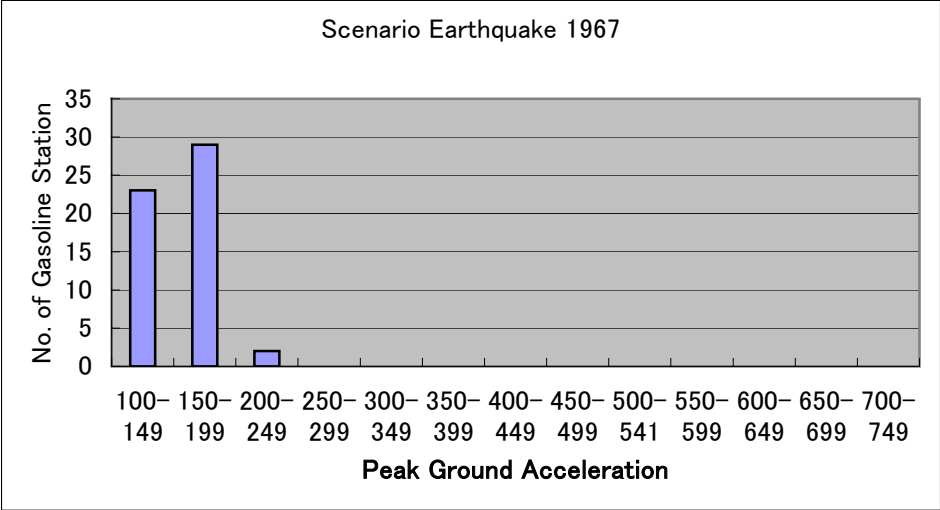
Figure 3.4.14   PGA and No. of Gasoline Stations
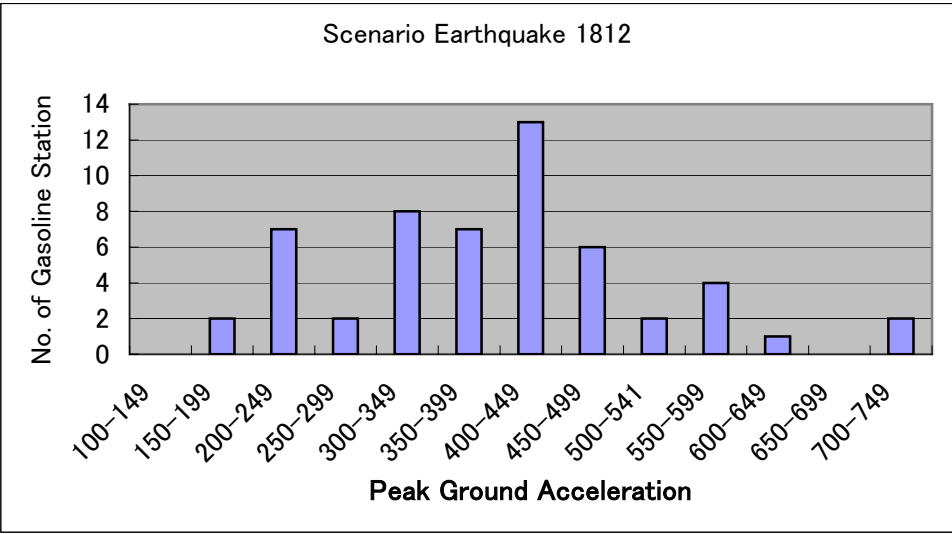
Figure 3.4.15   PGA and No. of Gasoline Stations
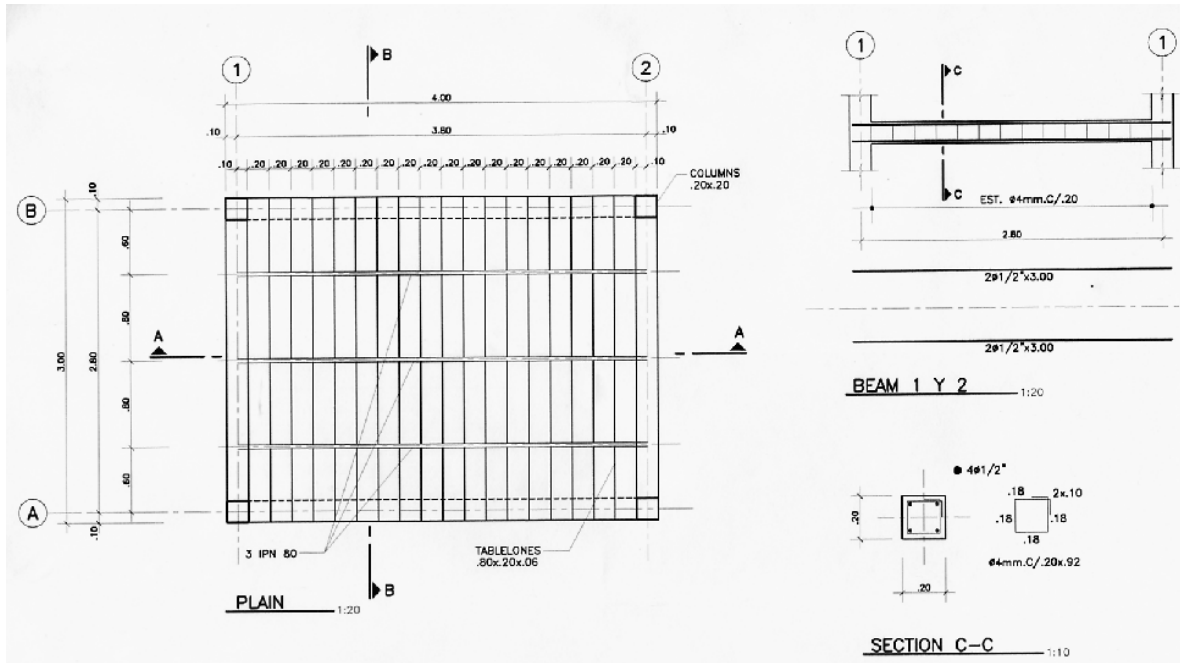
Figure 3.5.1   Floor Detail of Models
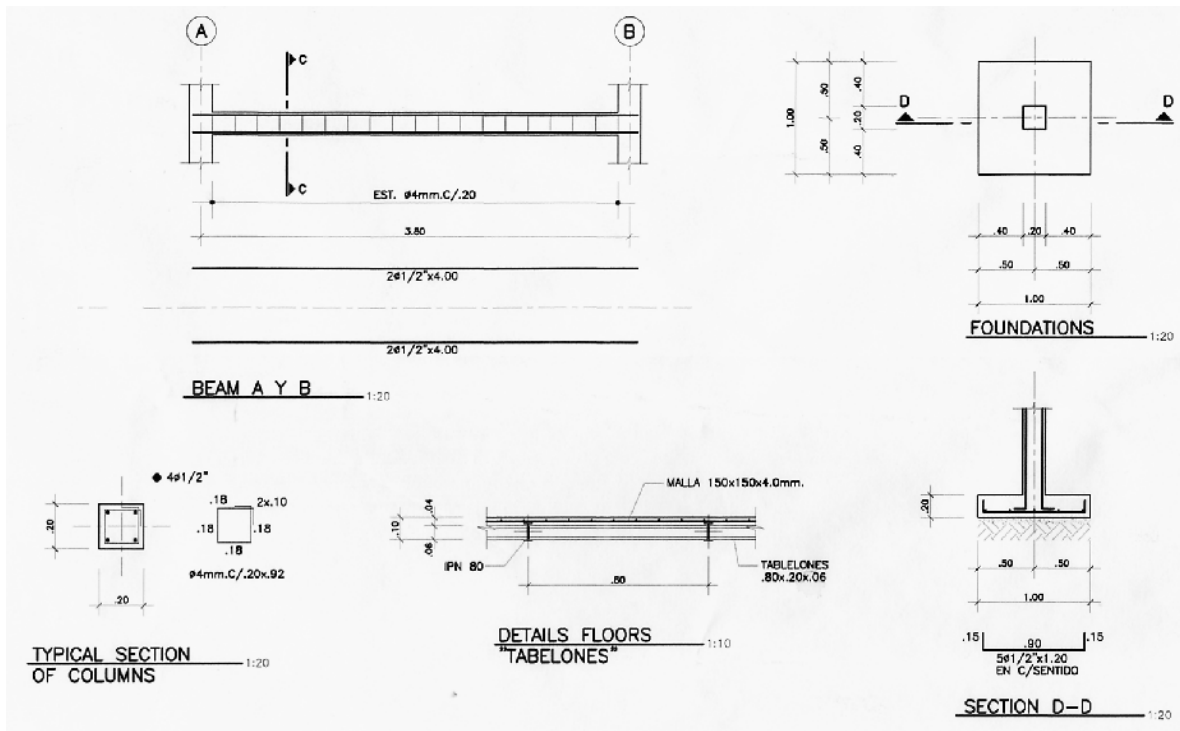
Figure 3.5.2   Floor and Foundation Detail of Models

CLAY BRICK WALL

HEIGH FREE 2.40

0.40

FRAME A Y B (SECTION A–A) 1:20
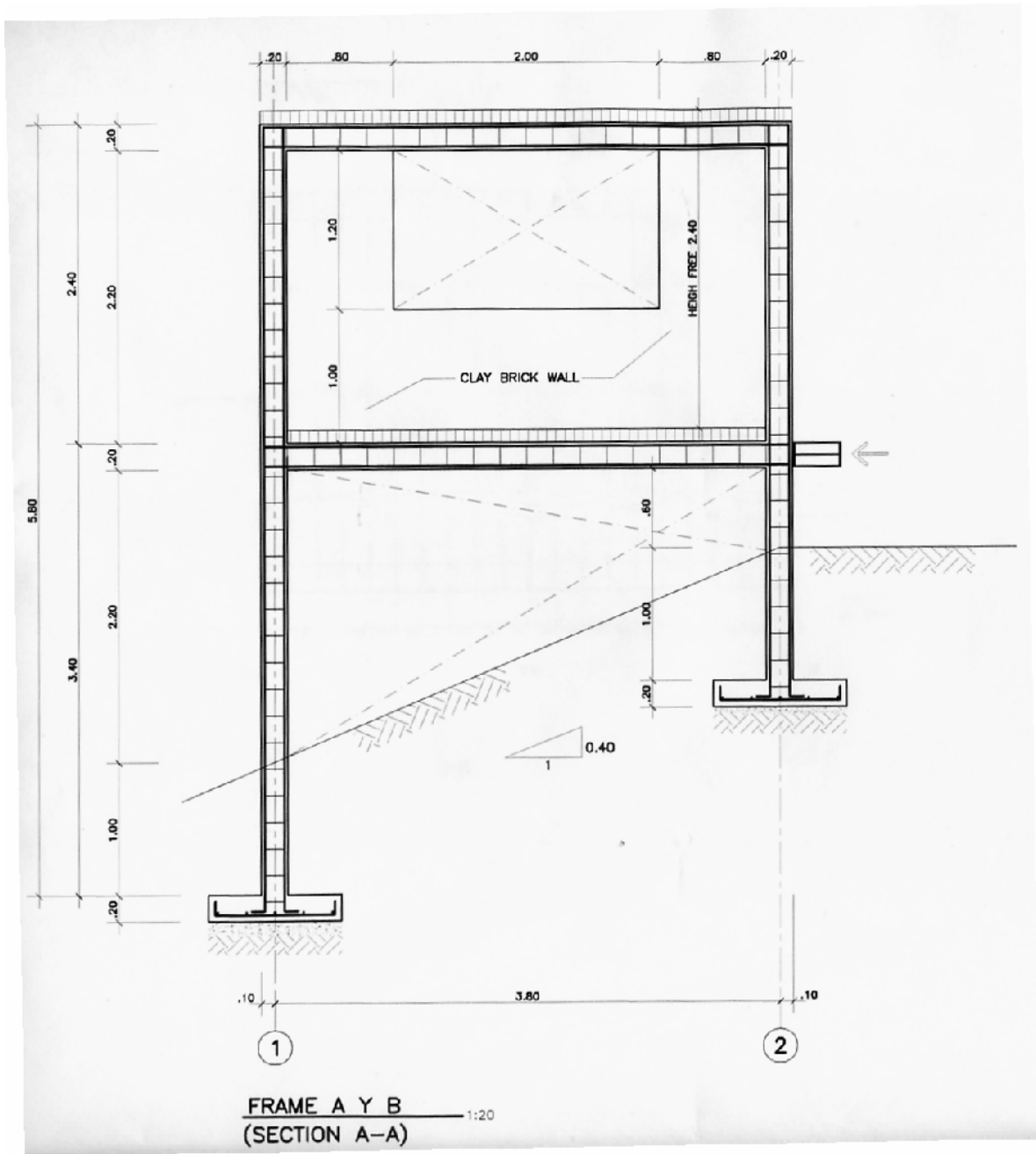
Figure 3.5.3   Framing Elevation of Model 1 (1)
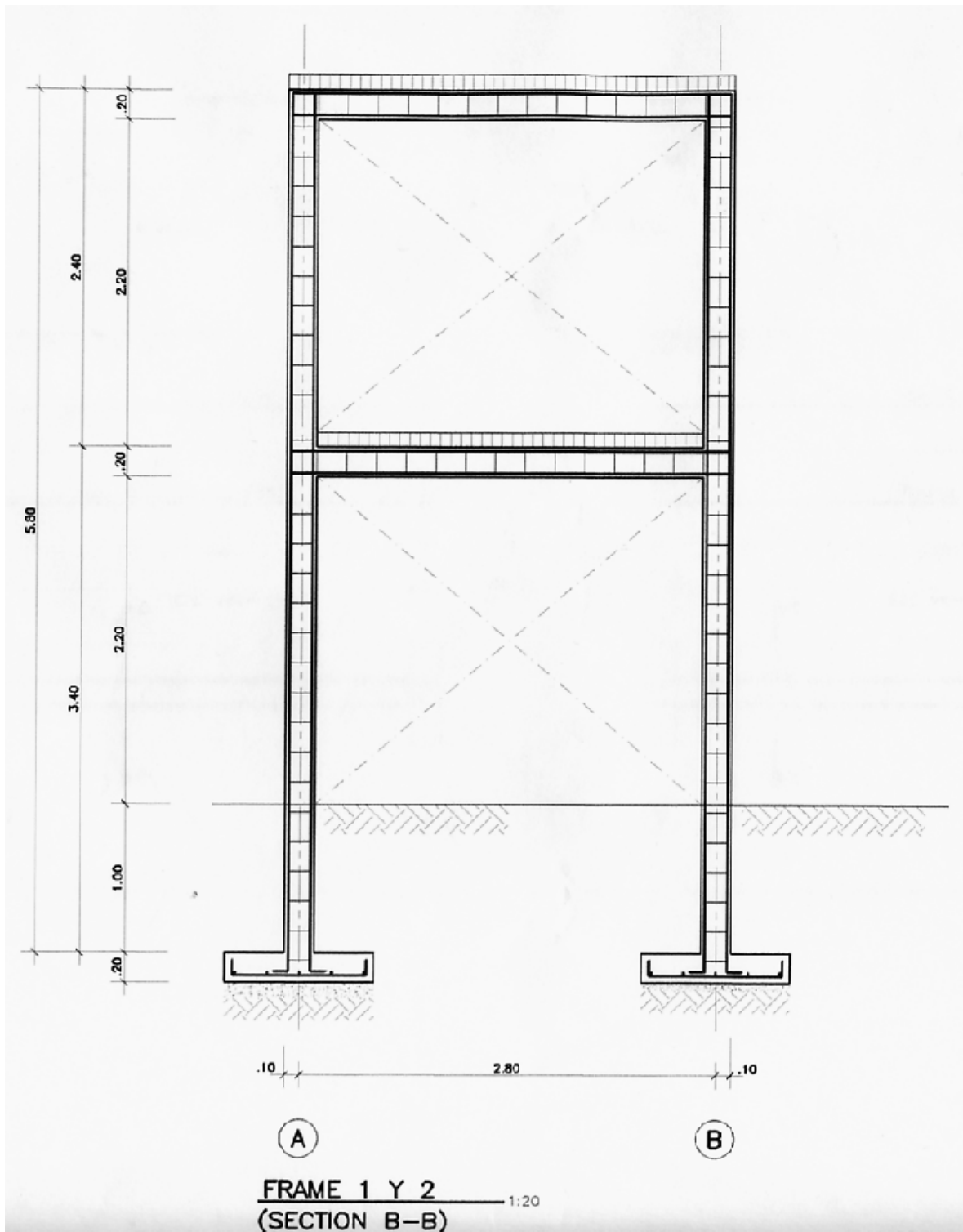
Figure 3.5.4 Framing Elevation of Model 1 (2)
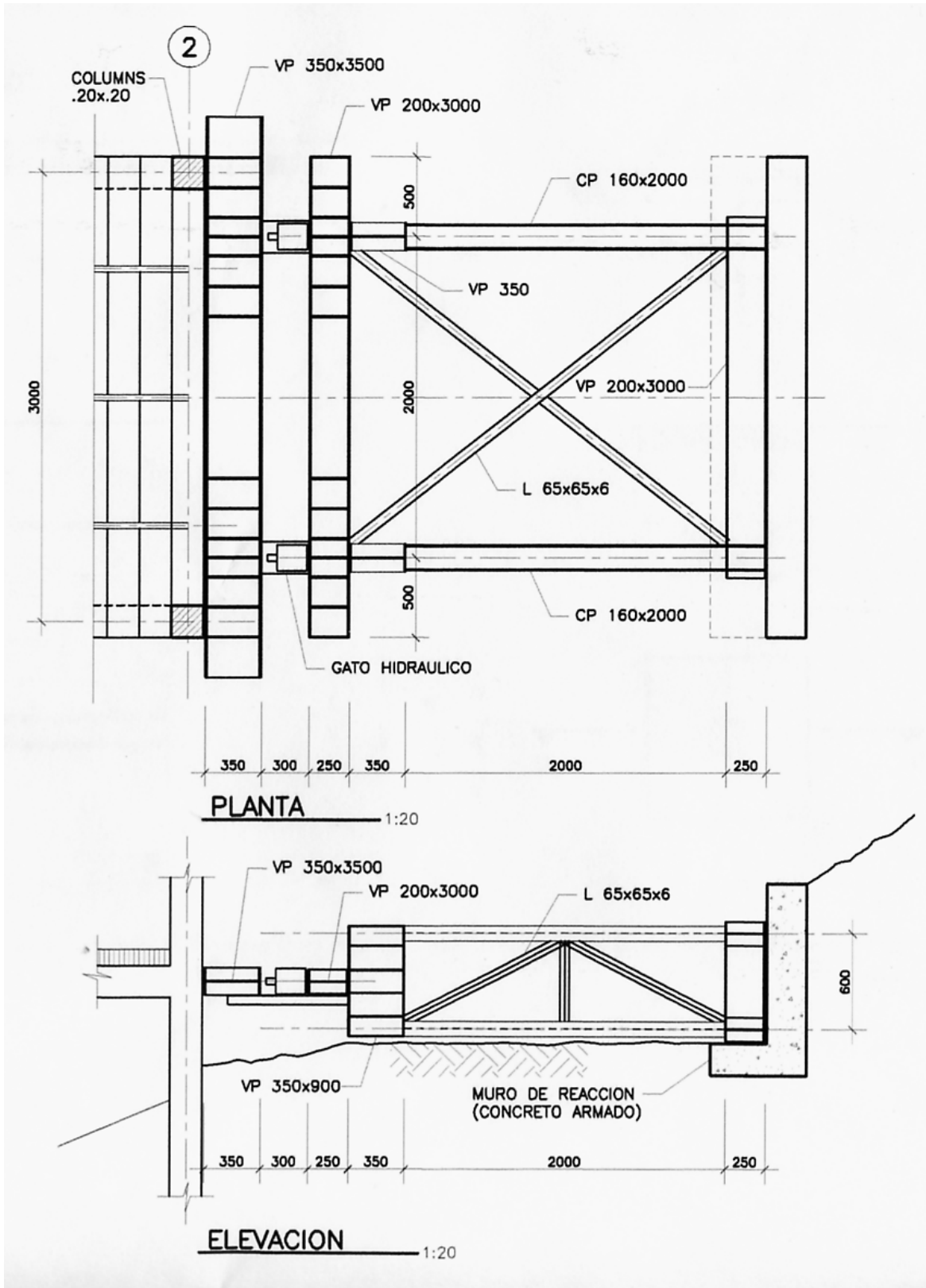
Figure 3.5.5   Horizontal Load Transfer Steel Frame

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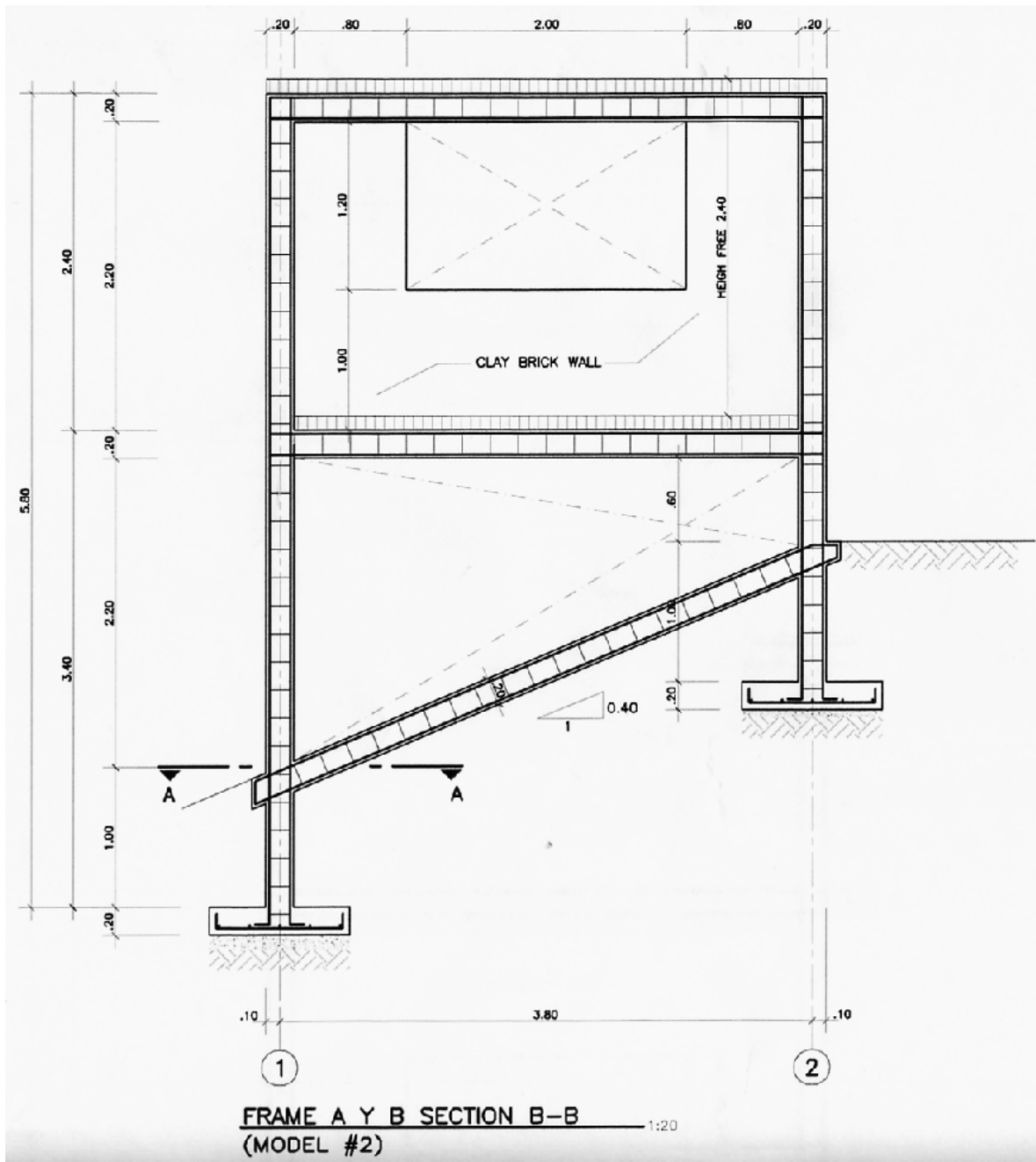
Figure 3.5.6   Framing Elevation of Model 2
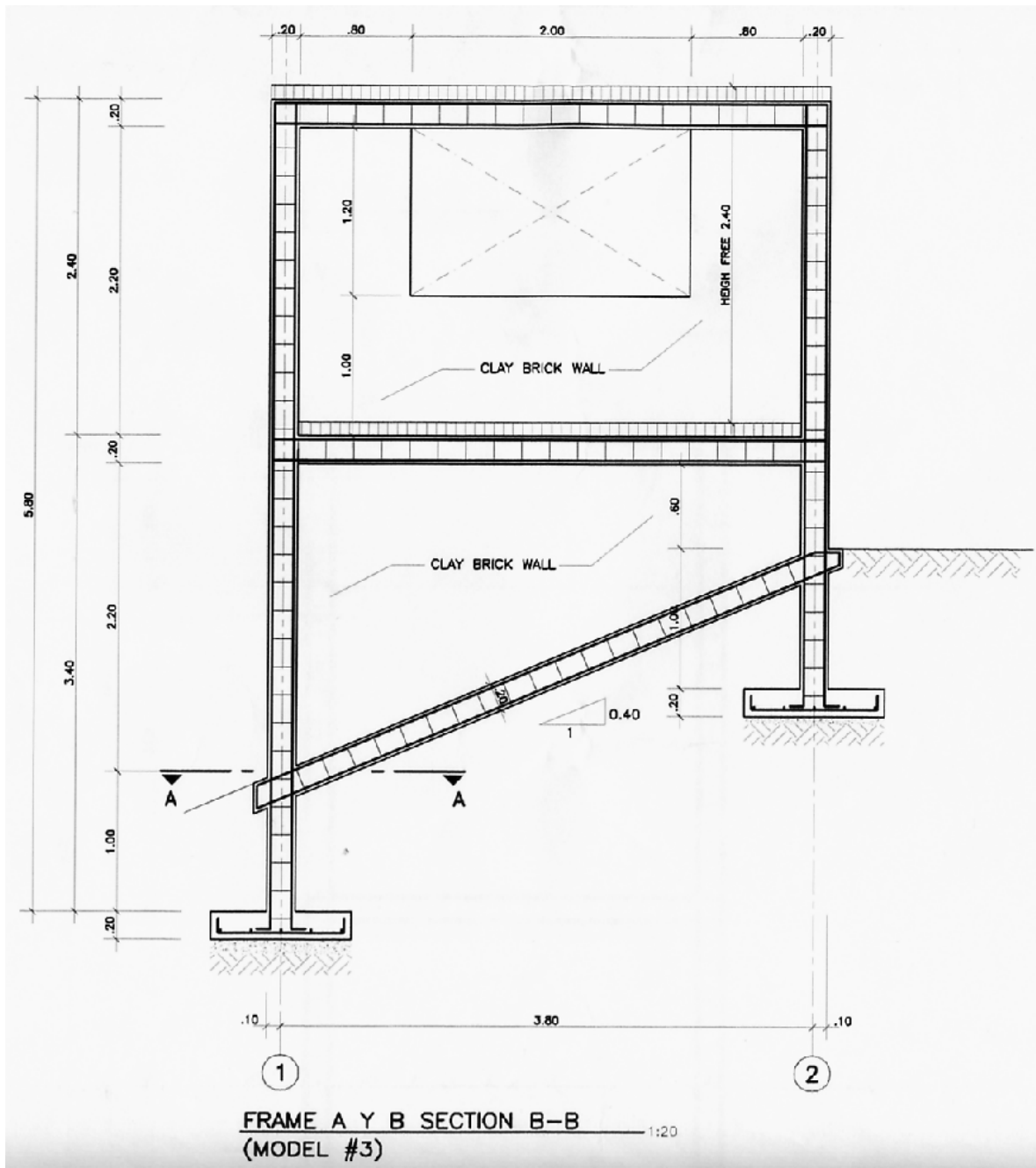
Figure 3.5.7   Framing Elevation of Model 3
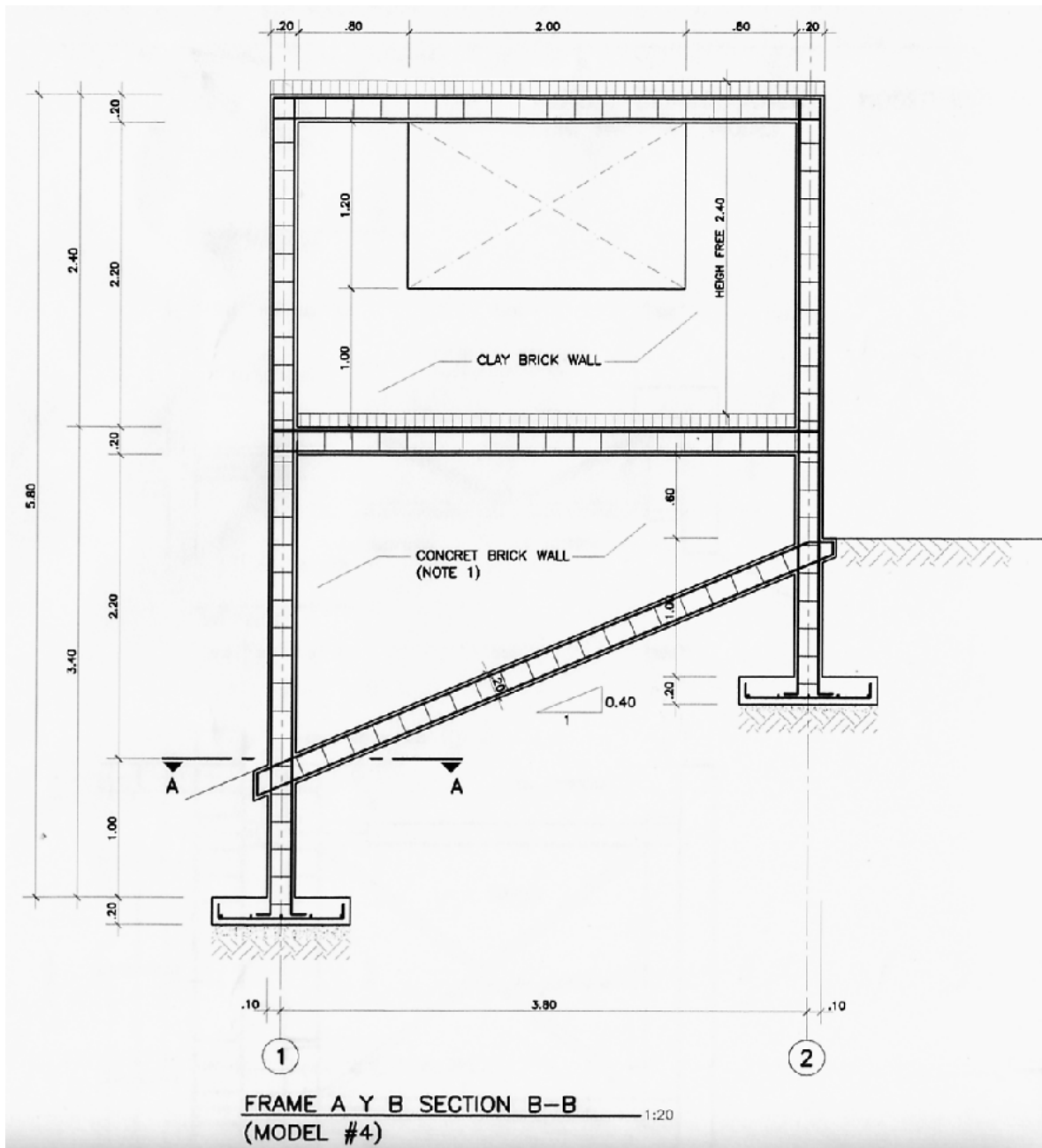
Figure 3.5.8   Framing Elevation of Model 4

FRAME A Y B SECTION B-B 1:20
(MODEL #2)

FRAME A Y B SECTION
(MODEL #3)

● 4∅1/2"
.15   2x.10
.15   .15
.15
∅4mm.C/.20x.80

SECTION C-C 1:10

TIPICAL GRADE BEAM REINFORCEMENT 1:10
(SECTION A-A)

● 4∅1/2"
.35   2x.10
.15   .15
.35
∅4mm.C/.20x1.20

REFERENC
STRUCTUR

4.00

3.00

PLAIN 1:100
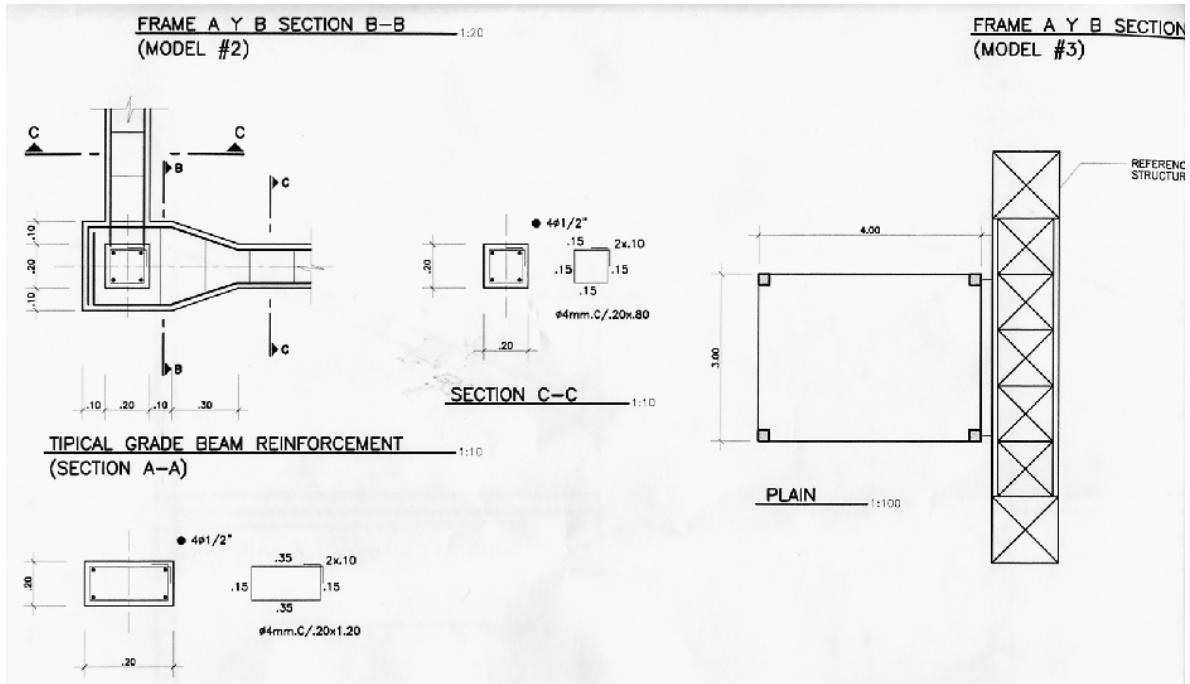
Figure 3.5.9   Grade Beam Detail and a Frame for Measurement

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FRAME A Y B SECTION B—B   1:20
(MODEL #4)

NOTES:
1.— ONE FACE WITHOUT REBARS
    ONE FACE WITH REBARS
    (ø3/8"C/.80 HORIZONTAL)
    (ø3/8"C/.60 VERTICAL)

2 FLEXIMETER
PER COLUMNS

REFERENCE
STRUCTURE
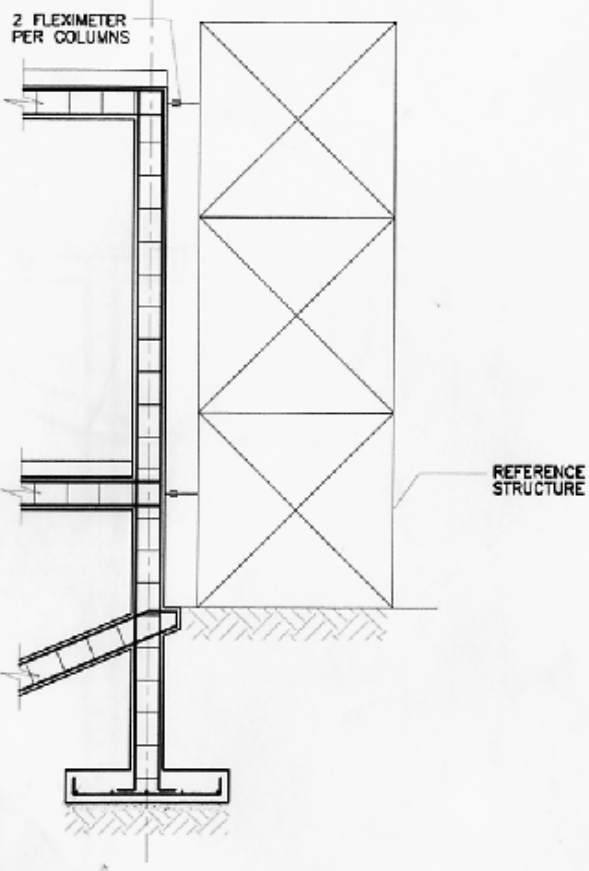
PARTIAL SECTION   1:20

Figure 3.5.10   Detail of a Frame for Measurement

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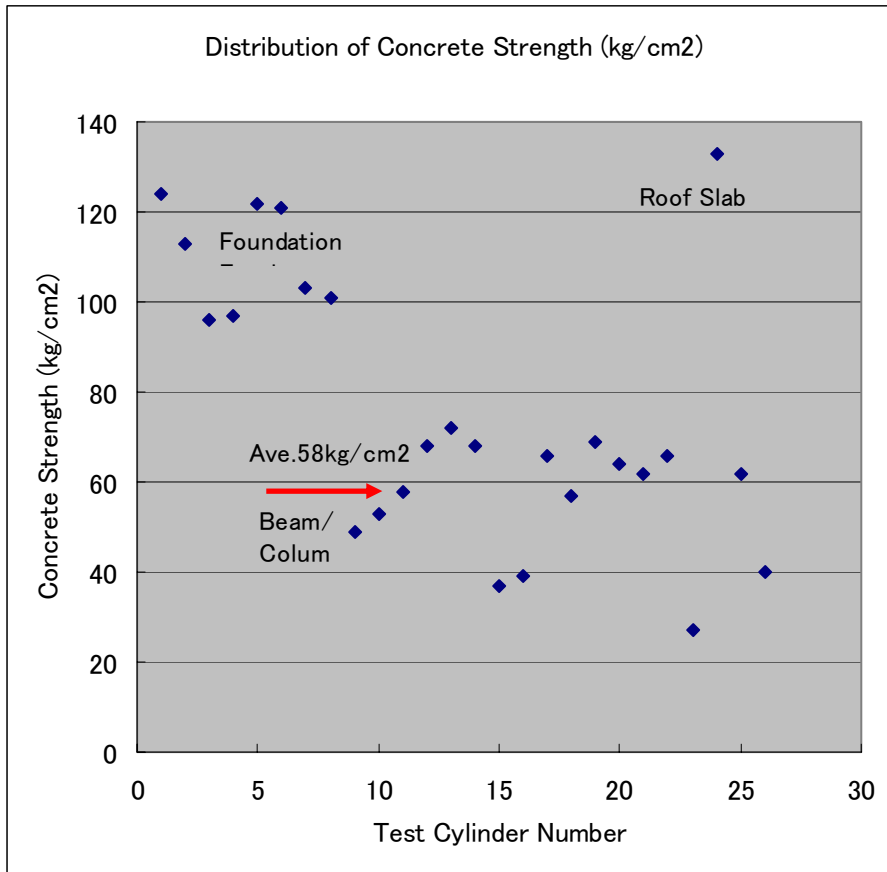
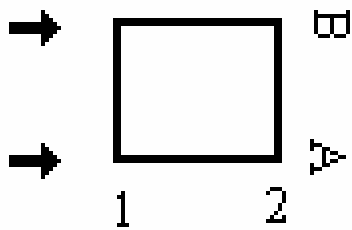**Figure 3.5.11   Distribution of Concrete Strength by Cylinder Test, Tested by IMME**
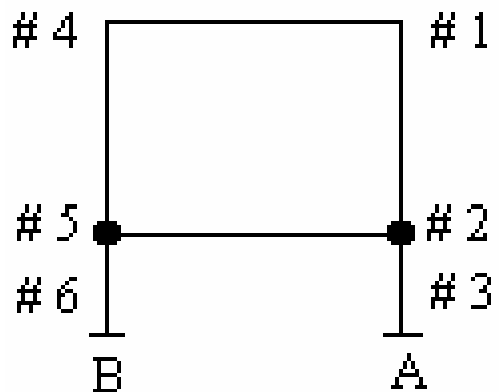

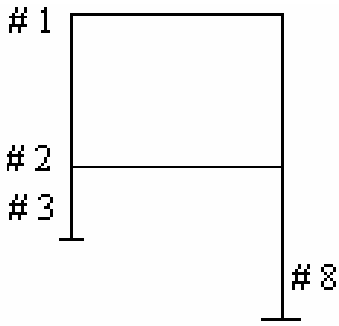**Figure 3.5.12   Plan of the Models**

Figure 3.5.13   Façade of Models
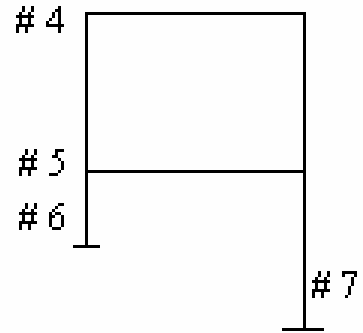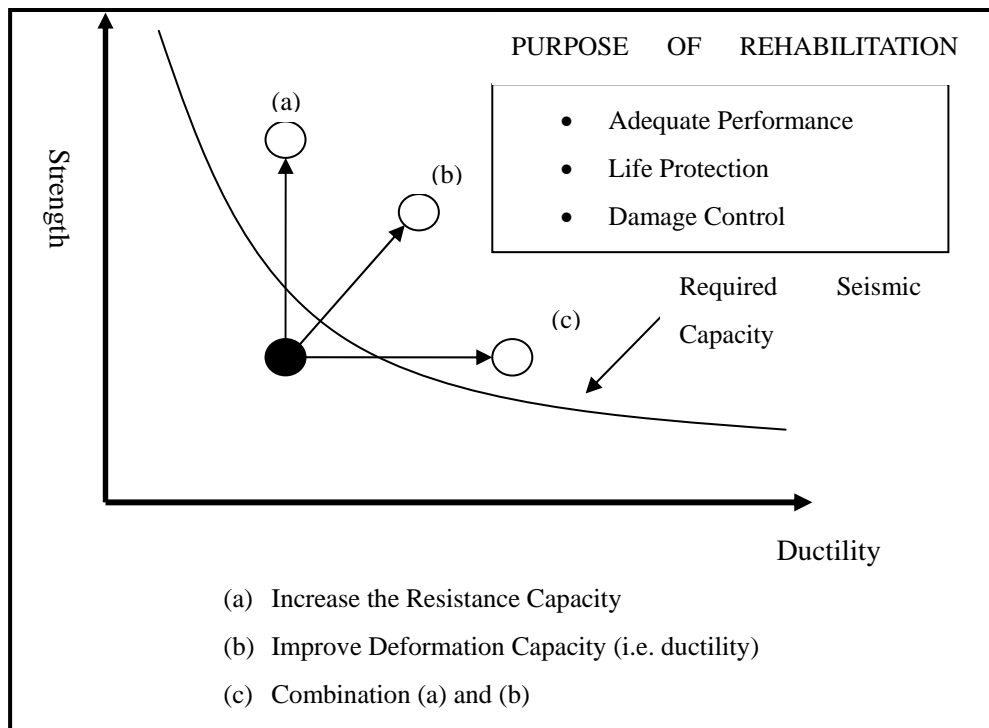
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Figure 3.5.14   Side View A

Figure 3.5.15   Side View B
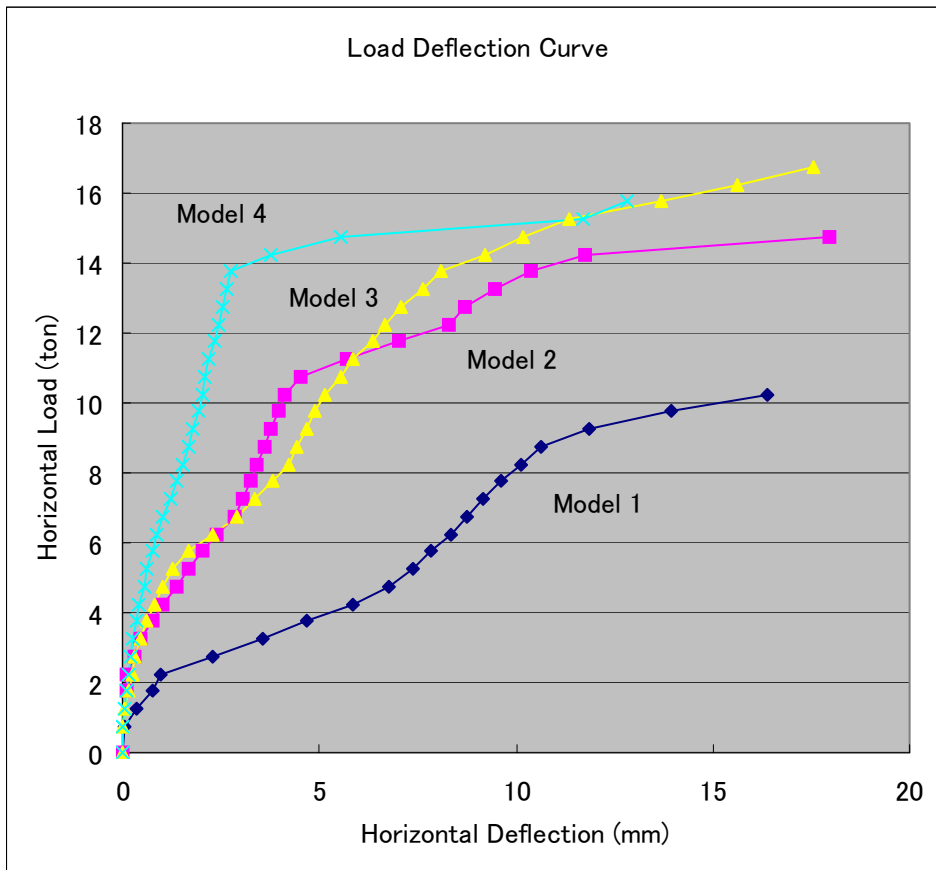
Figure 3.5.16   Load Deflection Curve

Strength (vertical axis)

(a)

(b)

PURPOSE OF REHABILITATION

- Adequate Performance
- Life Protection
- Damage Control

Required Seismic Capacity

(c)

Ductility

(a) Increase the Resistance Capacity
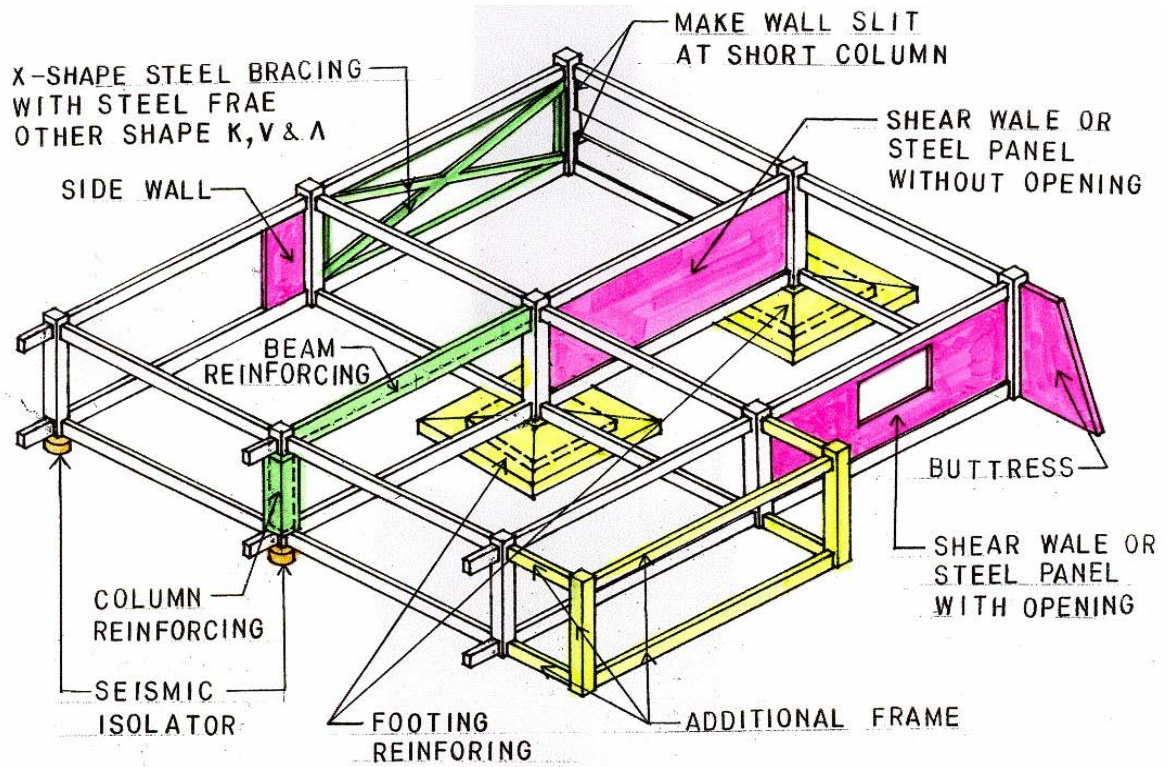
(b) Improve Deformation Capacity (i.e. ductility)

(c) Combination (a) and (b)

Source: Seismic Code of Venezuela 2001 "NORMA VENEZOLANA COVENIN 1756-98"

Figure 3.5.17   Basic Concept of Seismic Reinforcement

SEISMIC STRENGTHENING METHOD

Source: JICA Study Team

Figure 3.5.18　Seismic Reinforcement Methods for Existing RC and Steel Buildings

where: CB15; Concrete block wall in thk. of 150mm w/ reinforcing bar of
Vertical; D10 @ 800mm, Horizontal; 10∅ @ 600mm

SW8; RC shear wall in thk. of 80mm (Refer to Figure 3.2.7)

SW10; RC shear wall in thk. of 100mm (Refer to Figure 3.2.7)

SW12; RC shear wall in thk. of 120mm w/ reinforcing bar of D10 @ 250mm e.w.,
Anchor bar of D16 @250 (Similar to Figure 3.2.7)

SW15; RC shear wall in thk. of 150mm w/ reinforcing bar of D10 @ 200mm e.w.,
Anchor bar of D16 @250 (Similar to Figure 3.2.7)

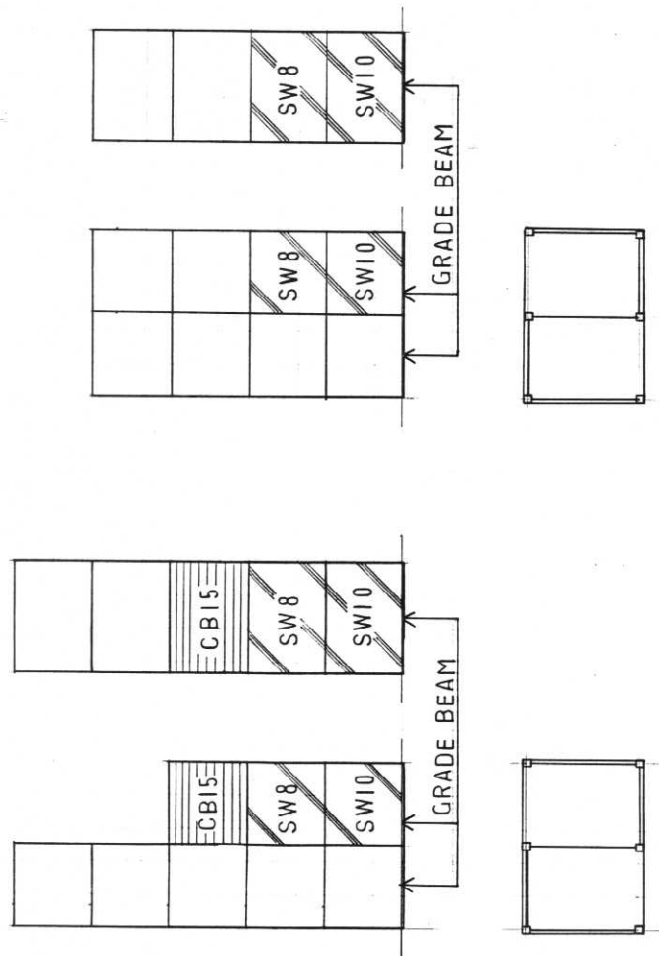Grade Beam; W200mm x D300mm w/4D13, Strr. 6∅@200mm

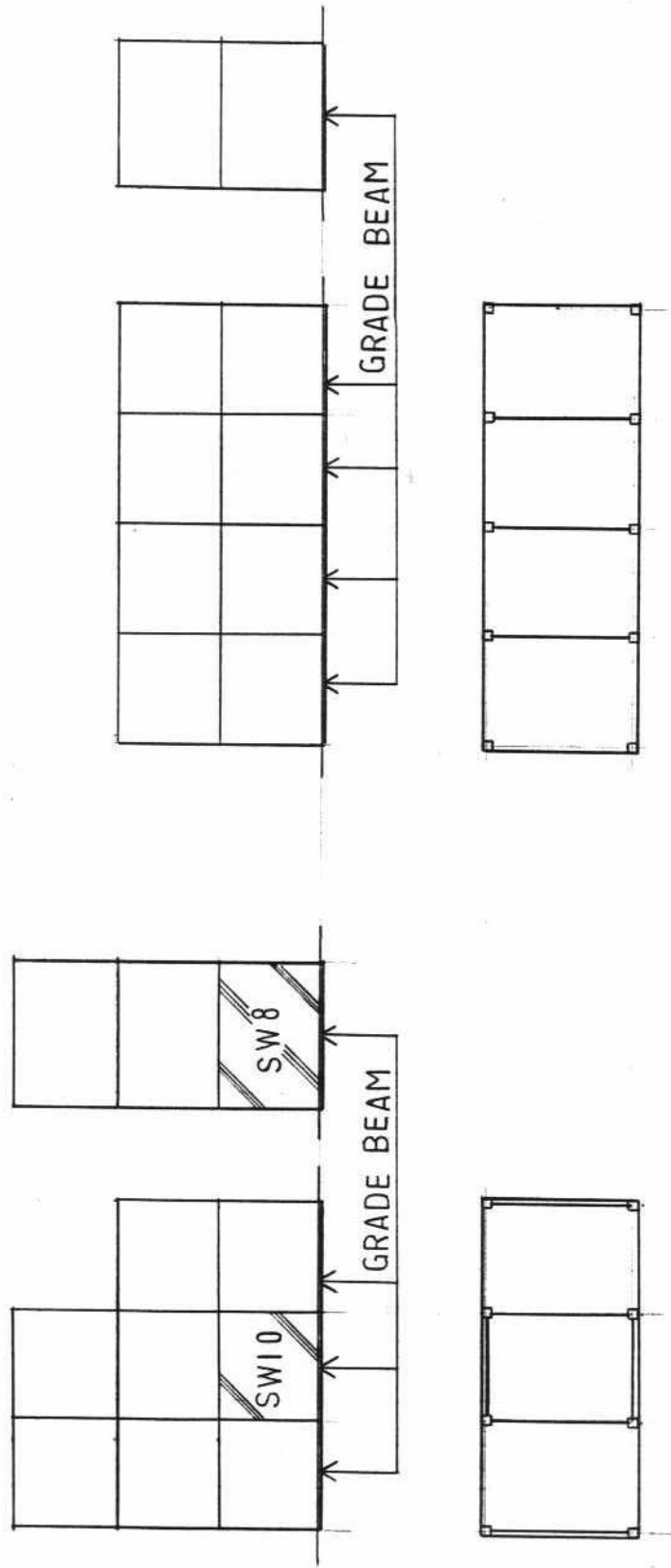**Figure 3.5.19(1)   Recommended Seismic Reinforcement Methods for a Single Family House**

Figure 3.5.19(2)   Recommended Seismic Reinforcement Methods for a Single Family House