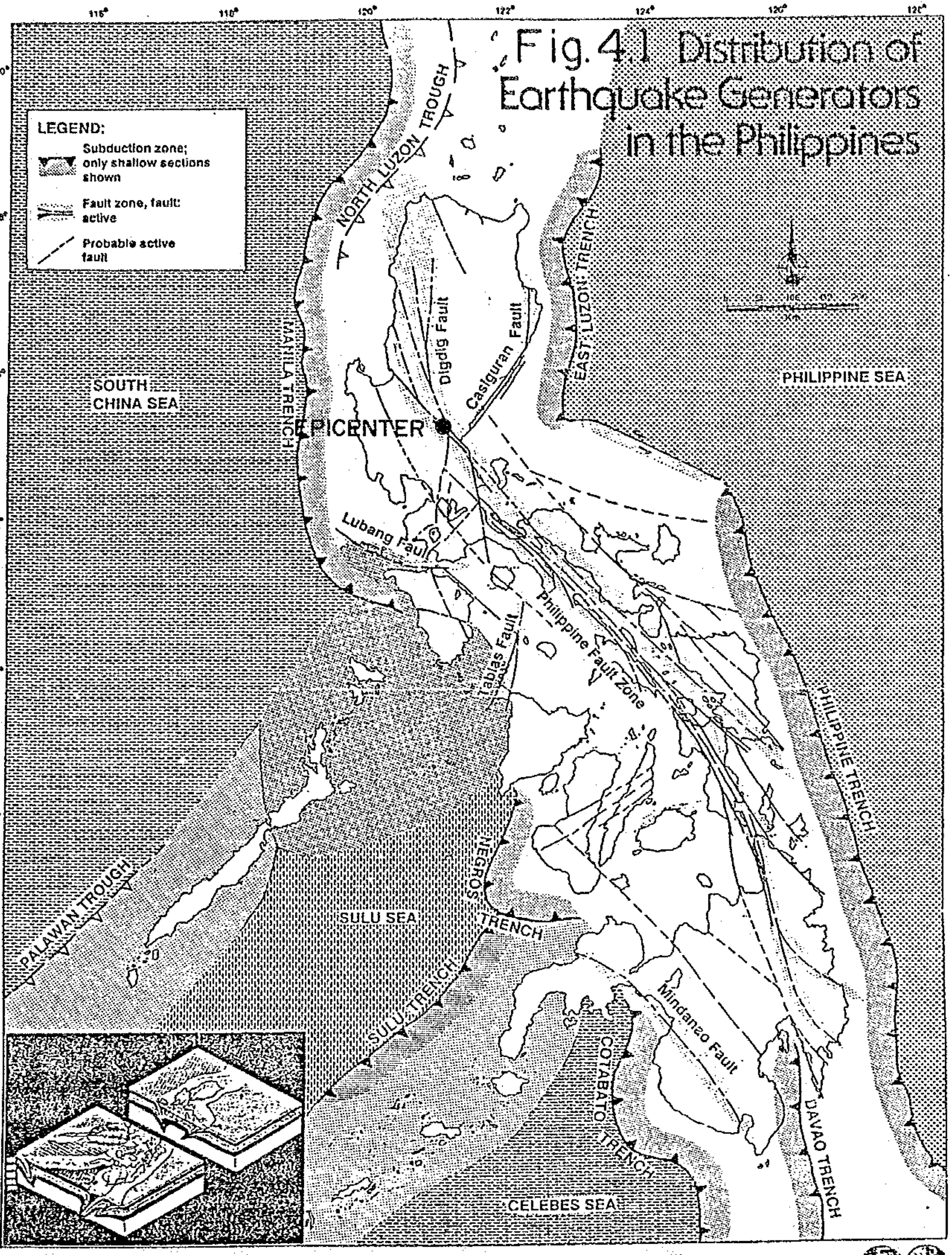

Fig. 4.1 Distribution of Earthquake Generators in the Philippines

There are eight major and several minor earthquake generators in the Philippines. These are zones or belts where differential movements of solid materials are likely to occur and consequently trigger the generation of earthquakes. Depending on the respective nature and trajectory of propagation into the earth's interior of the earthquake generators, the foci of the resulting earthquakes may either be near the surface or at depths of up to 700 km. The Philippine Archipelago is one of the world's most tectonically and, therefore, seismically active areas. Statistically speaking, the Philippine hosts at least five imperceptible to perceptible earthquakes per day.

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OF VOLCANOLOGY
AND SEISMOLOGY

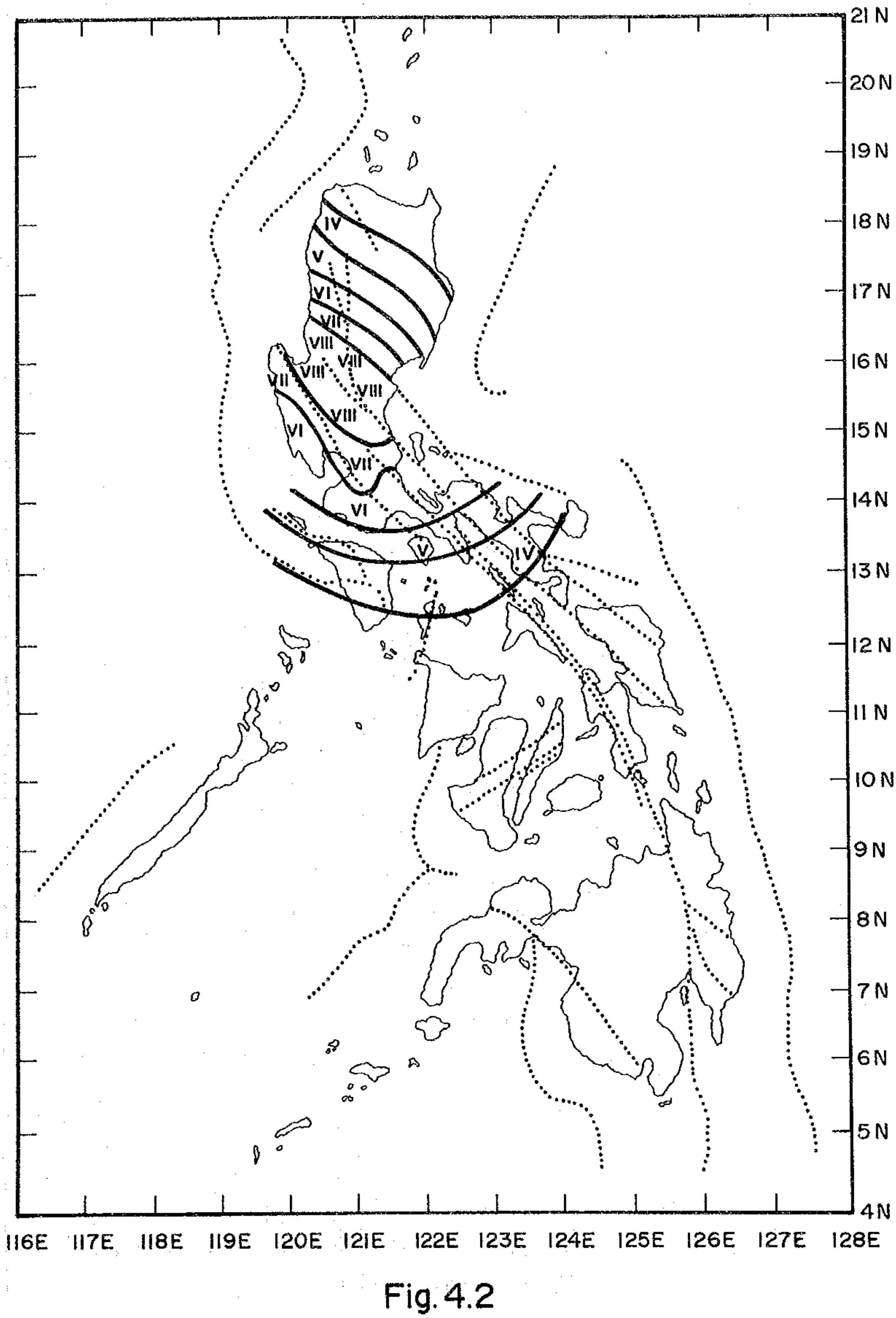


Fig. 4.2

ISOSEISMAL MAP OF
THE 16 JULY 1990 EARTHQUAKES

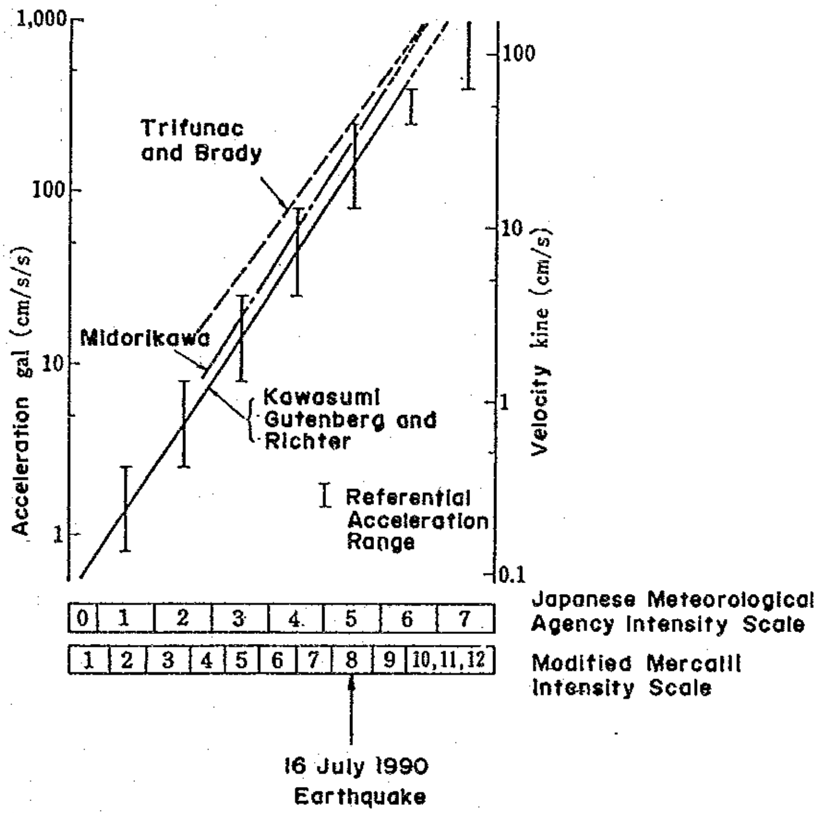


Fig. 4.3 RELATION BETWEEN SEISMIC INTENSITY AND ACCELERATION

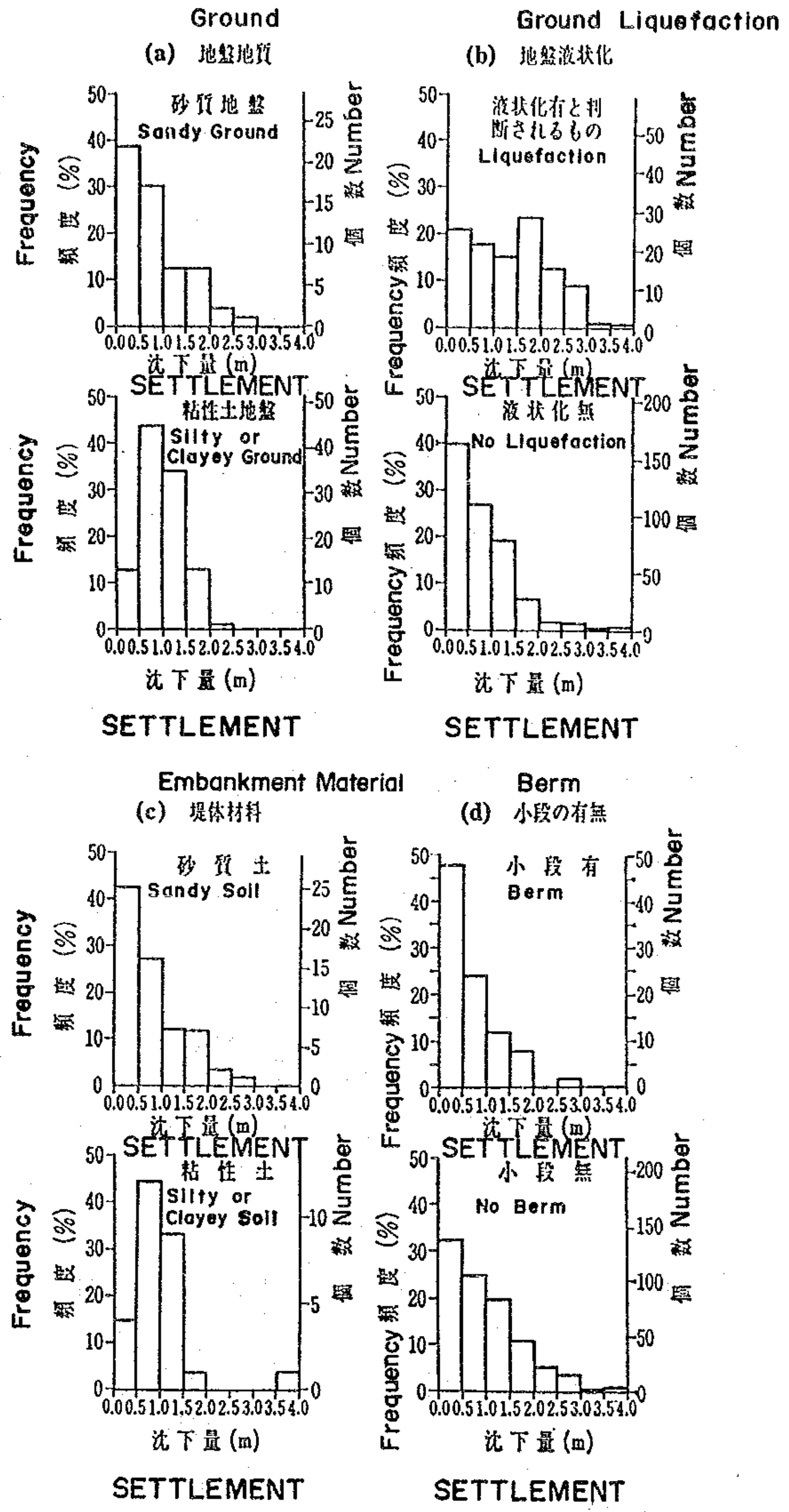


Fig. 5.1 SETTLEMENT OF DAMAGED RIVER DYKES

Ⅰ 型 のり面崩壊

TYPE I Slope Surface Failure

Ⅱ 型 堤体破壊

TYPE II Slope Failure

Ⅲ 型 地盤と堤体の破壊

TYPE III Ground and Embankment Failure

Ⅳ 型 堤体沈下

TYPE IV Sink of Embankment

堤防の被害形態

Fig. 5.2 DAMAGED SHAPES OF RIVER DYKES

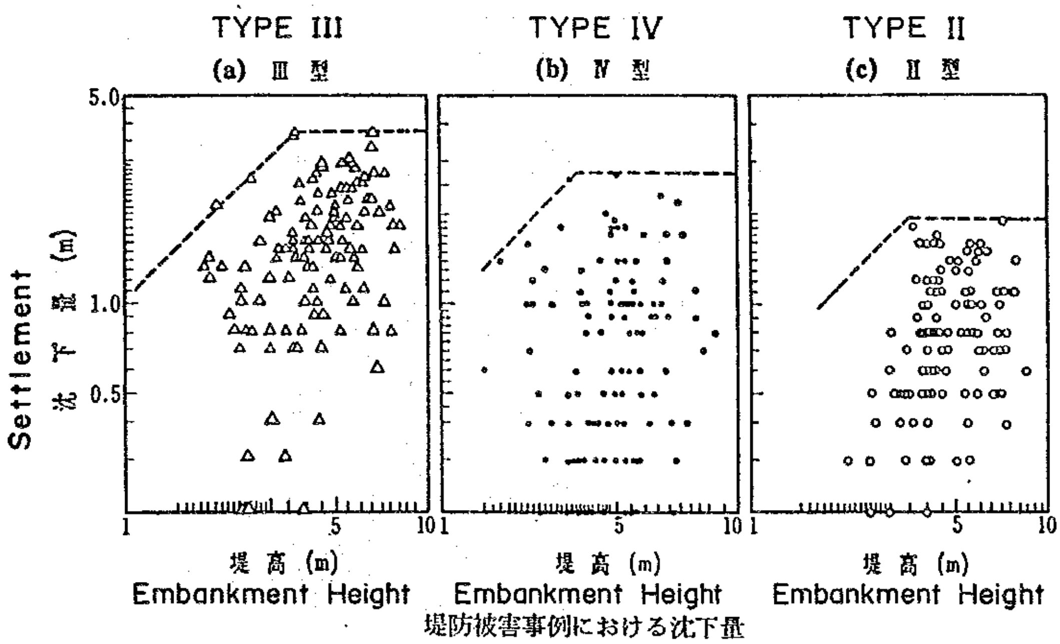
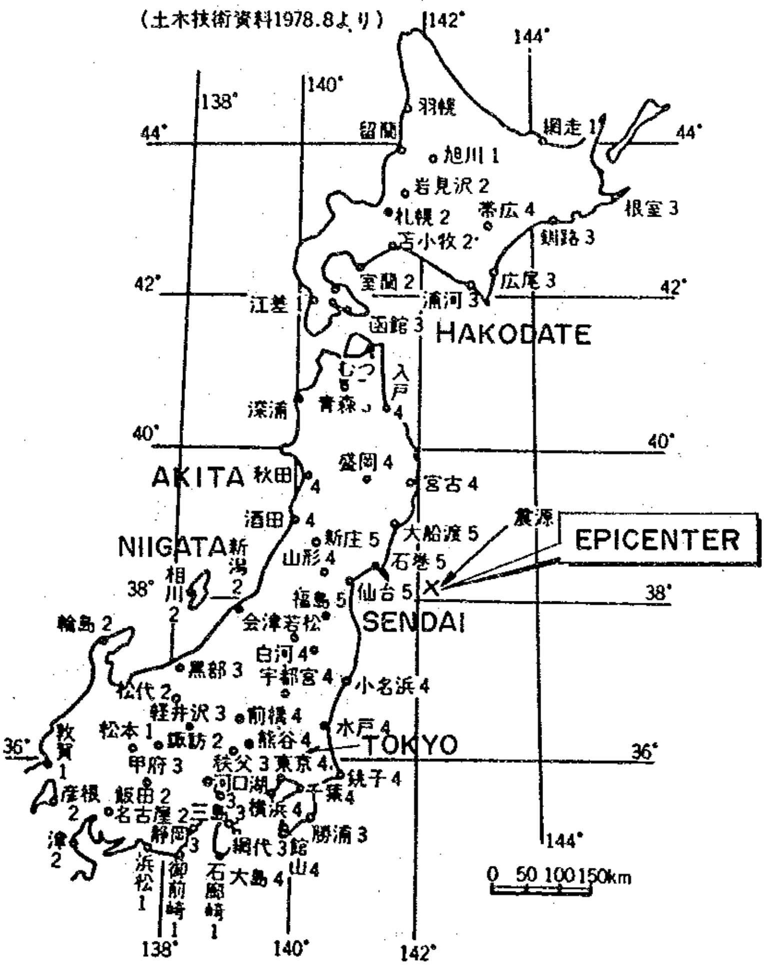
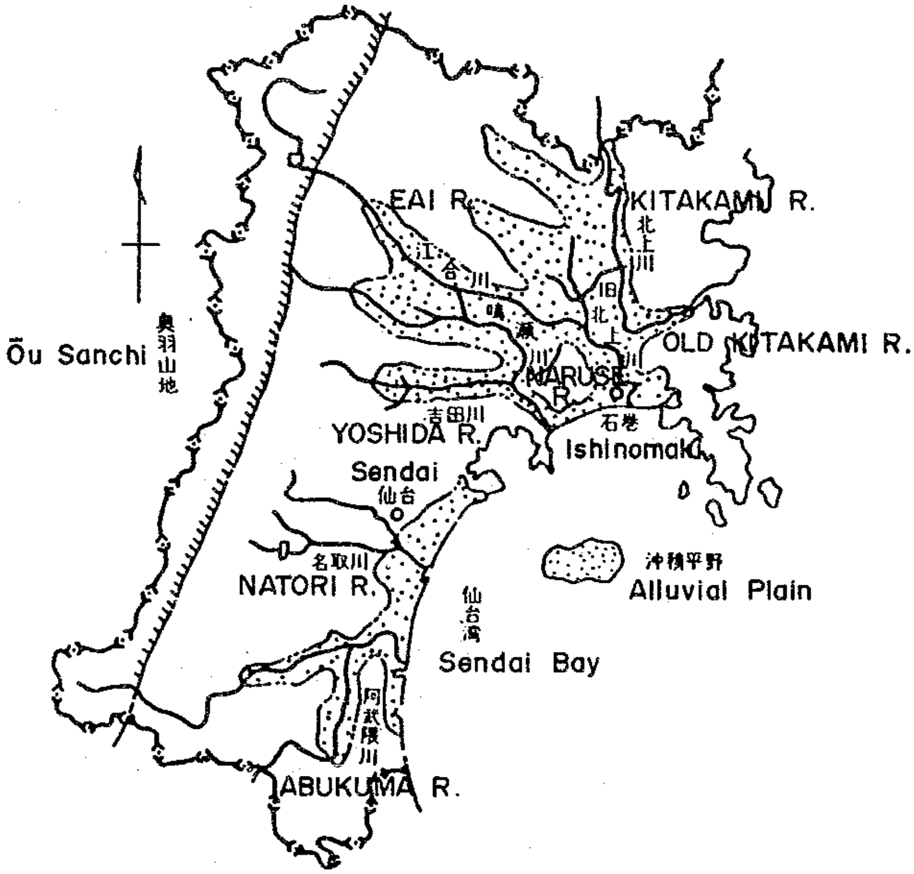


Fig. 5.3 SETTLEMENT OF DAMAGED RIVER DYKES



震源地と各地の震度

Fig. 5.4 LOCATION OF EPICENTER AND INTENSITY



宮城県流域図

県内一級河川

河川名	北上川	旧北上川	江合川	鳴瀬川	吉田川	名取川	阿武隈川	合　計
延長(km)	57.4	35.0	35.7	45.5	36.9	18.9	54.6	284.0

Fig. 5.5 SEVEN RIVERS IN MIYAGI - KEN

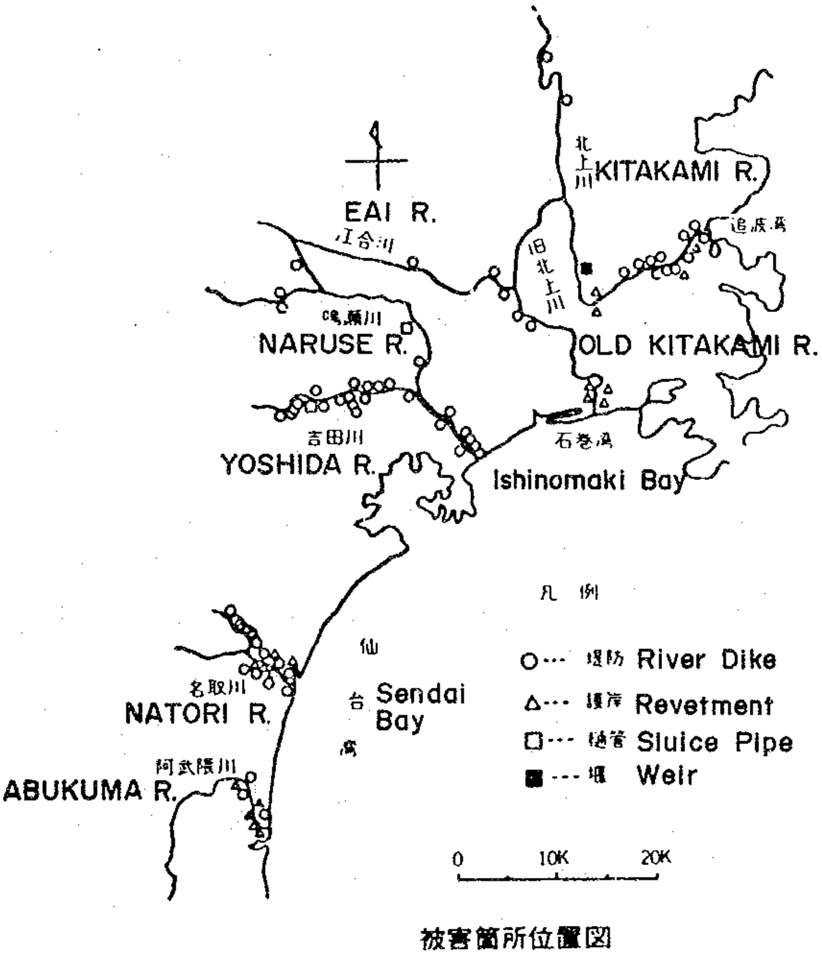


Fig. 5.6 LOCATION OF DAMAGED PLACE

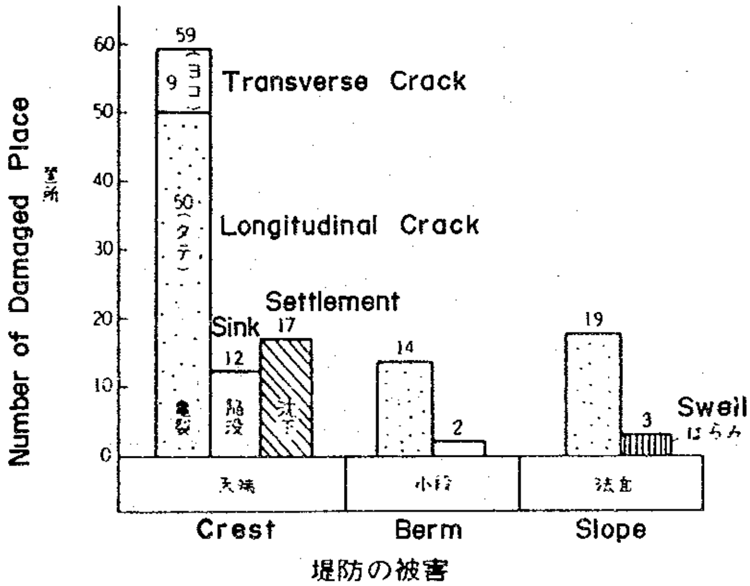
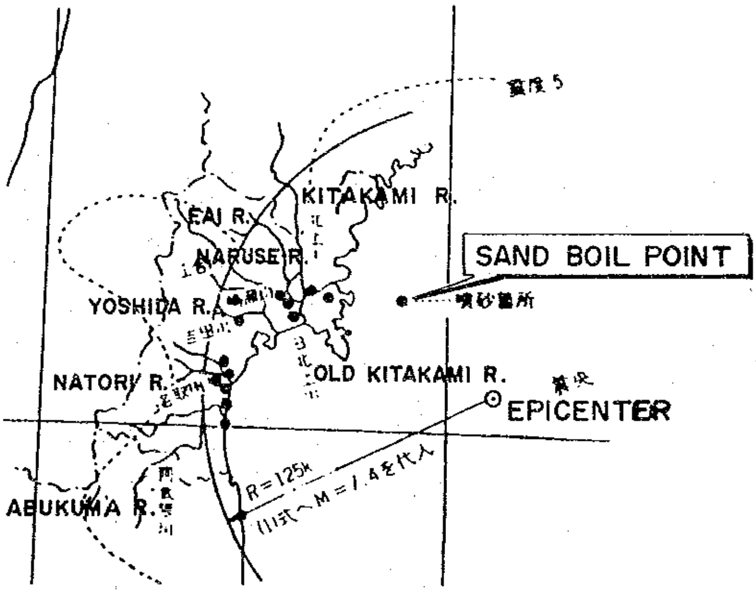
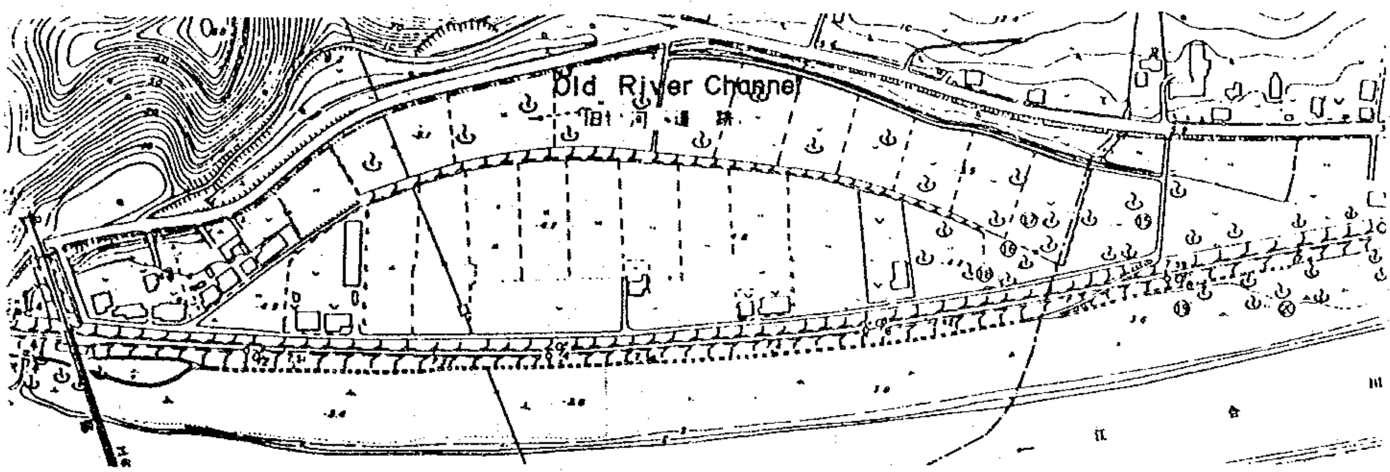


Fig. 5.7 DAMAGE OF RIVER DYKE



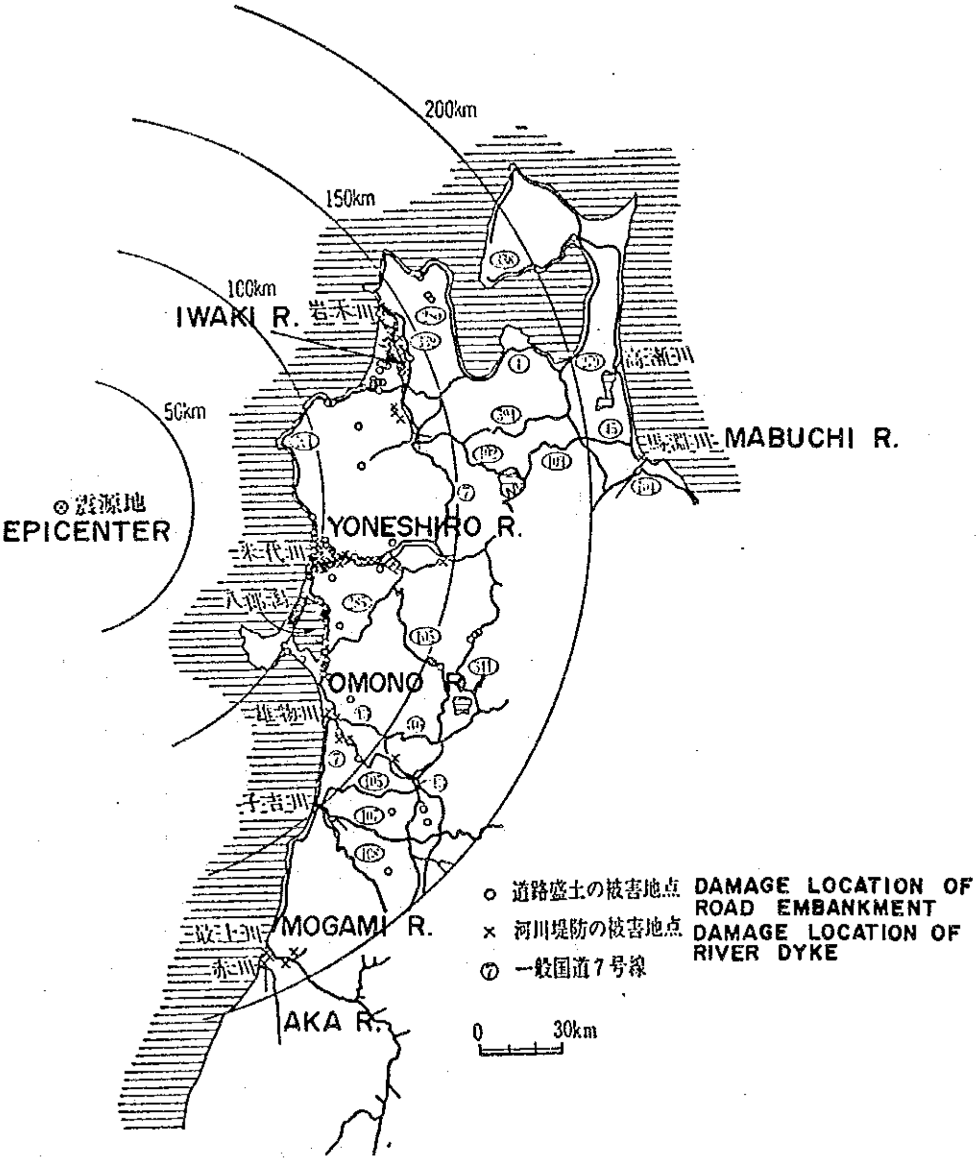
噴砂発生箇所

Fig. 5.8 SAND BOIL POINT



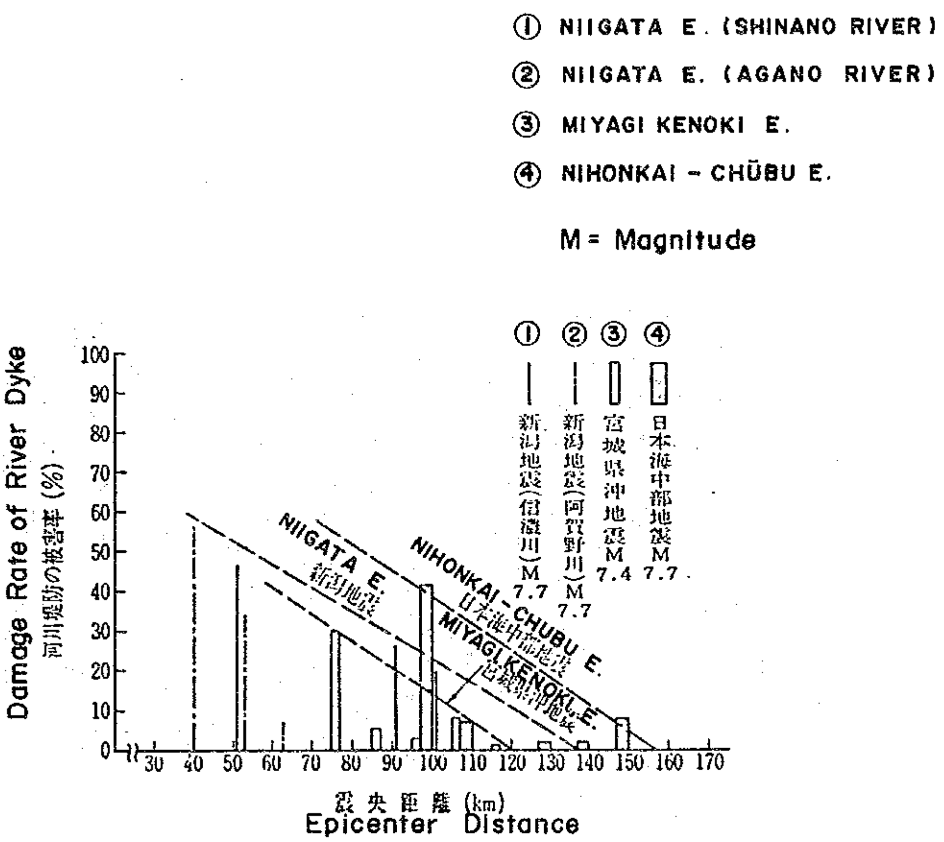
江会川右岸（旧北上川合流点～1.0K）旧河道跡にみられる噴砂箇所　山……噴砂箇所
Sand Boil

Fig.5.9 SAND BOIL IN OLD RIVER CHANNEL AT RIGHT BANK OF EAI RIVER



道路盛土，河川堤防の被害地点

Fig. 5.10 DAMAGE LOCATION OF RIVER DYKE



震央距離と河川堤防の被害率

Fig. 5.11 RELATION BETWEEN EPICENTER DISTANCE AND DAMAGE RATIO OF RIVER DYKE

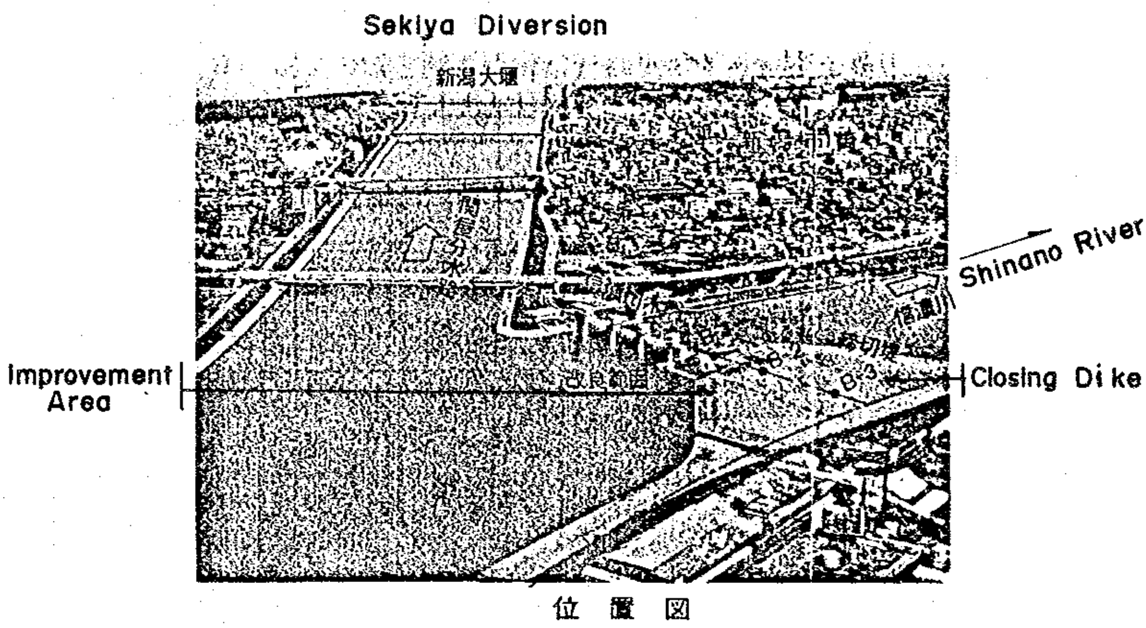
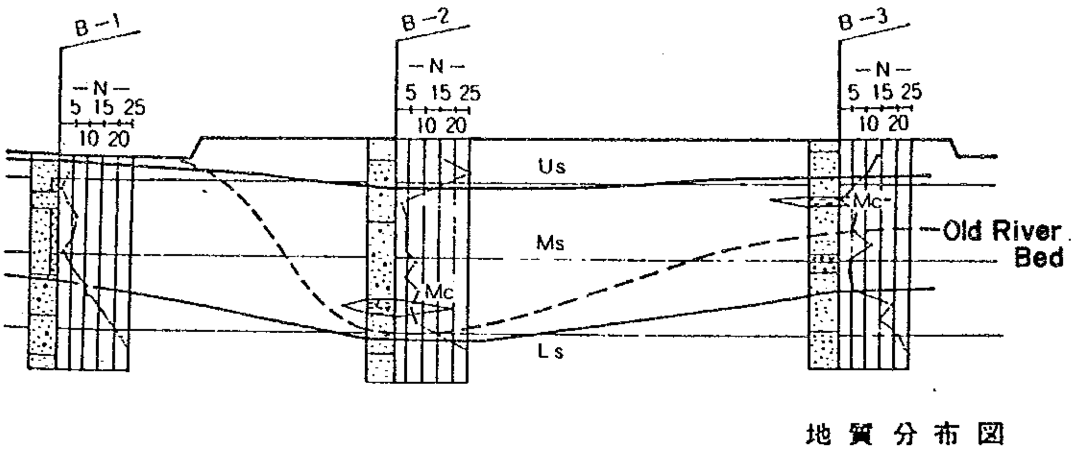
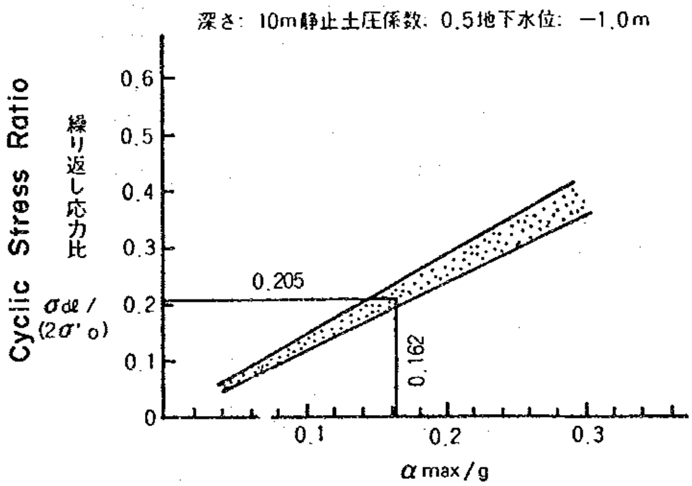


Fig. 5.12 LOCATION MAP



DEPOSIT CLASSIFICATION	SOIL	SIGN	N VALUE	REMARKS
Upper Layer	Sandy Soil (Fine Sand)	U_s	More than 10	About 1 m. of upper part is yellowish grey, a litte compacted.
Middle Layer	Sandy Soil (Fine to Coarse Sand)	M_s	1~10	Much water content, loose, organic materials mixed, small gravels (Ø = 2-3 mm).
	Clayey Soil (Clay~Sandy Silt)	M_c	1~6	Contain soft and many organic materials irregular layer thickness of 1cm.~several cm.
Lower Layer	Sandy Soil (Medium Sand)	L_s	10	Equal Particle size on the whole, little content of clay and silt.

Fig. 5.13 GEOLOGICAL CROSS SECTION



最大加速度と20回に換算した
一様繰り返し応力比との関係

Fig. 5.14 RELATION BETWEEN MAXIMUM ACCELERATION AND UNIFORM CYCLIC STRESS RATIO CONVERTED BY 20 CYCLES

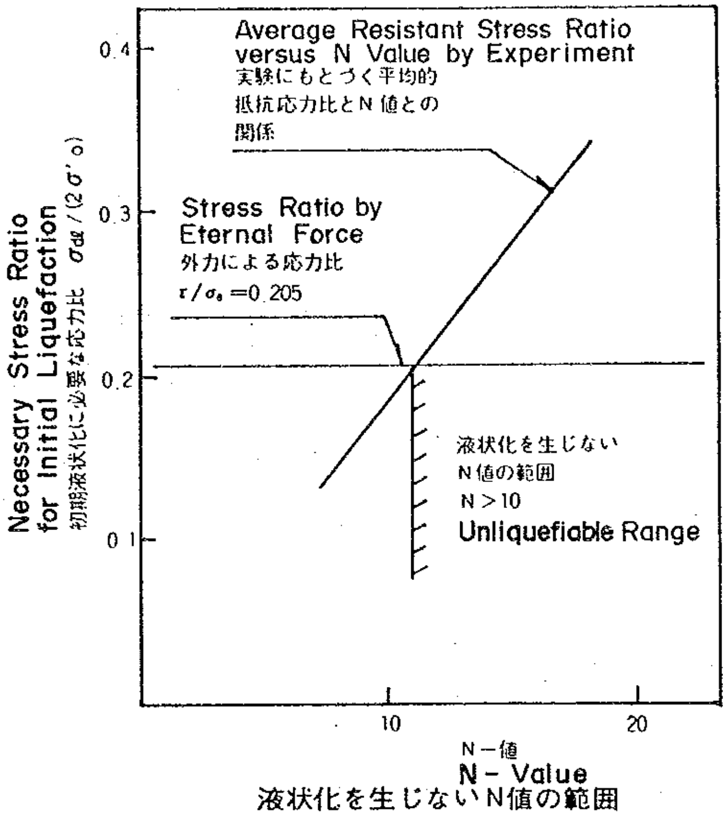


Fig. 5.15 UNLIQUEFIABLE RANGE OF N VALUE

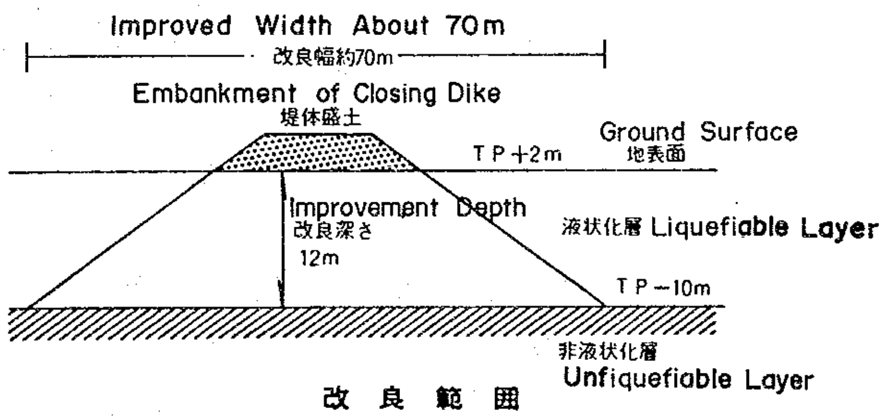


Fig. 5.16 IMPROVEMENT RANGE

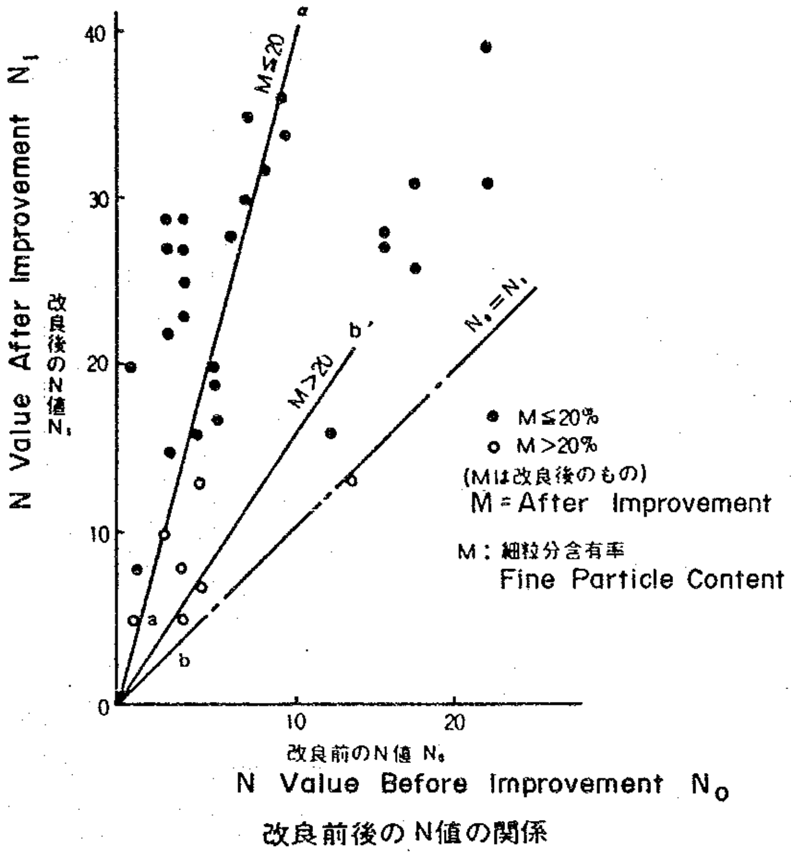


Fig. 5.17 RELATION BETWEEN N VALUE BEFORE AND AFTER IMPROVEMENT

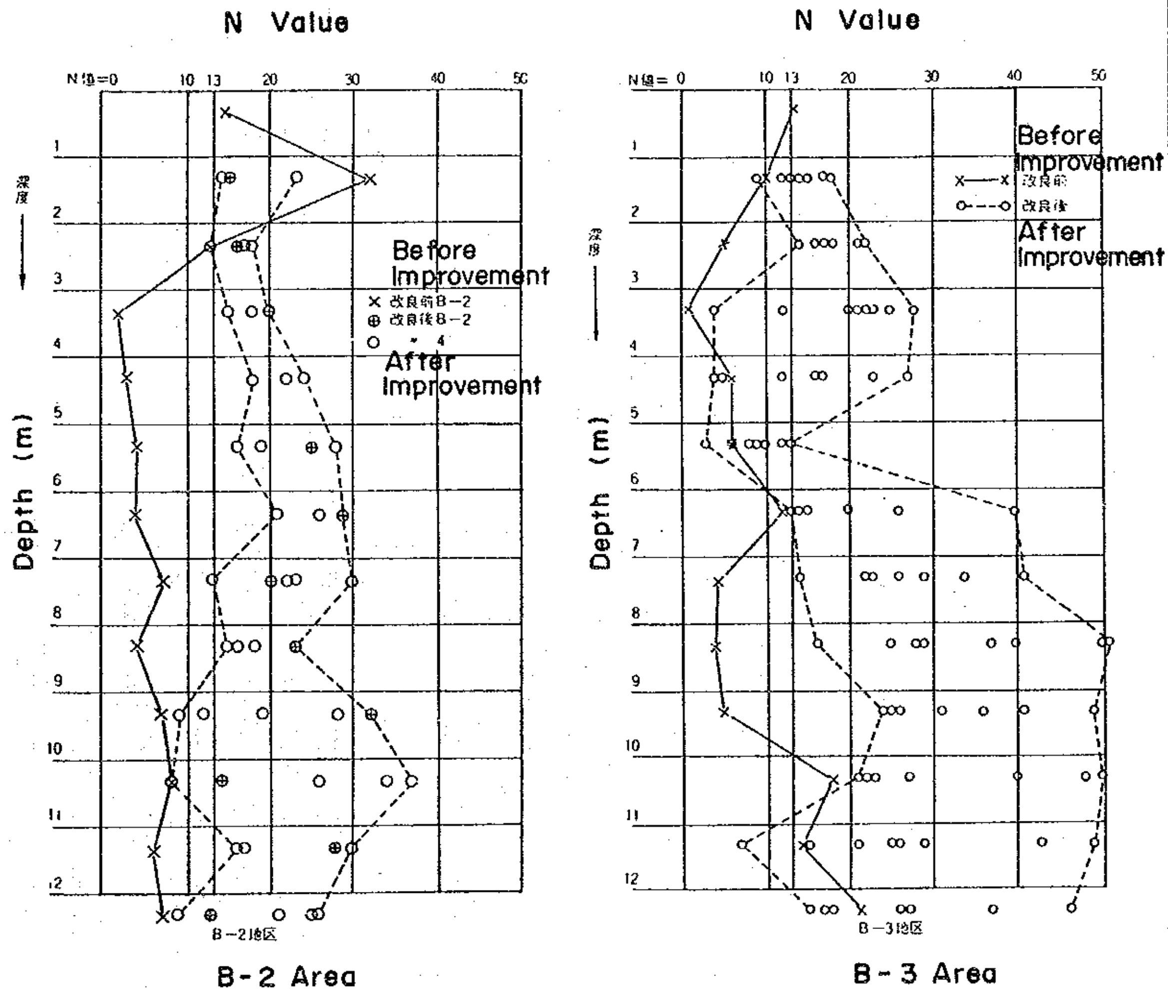
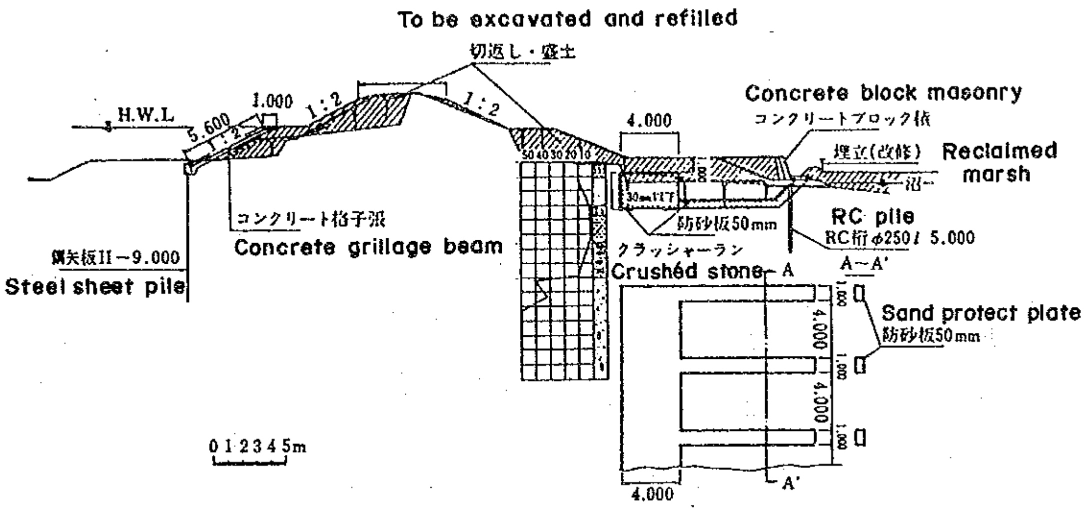
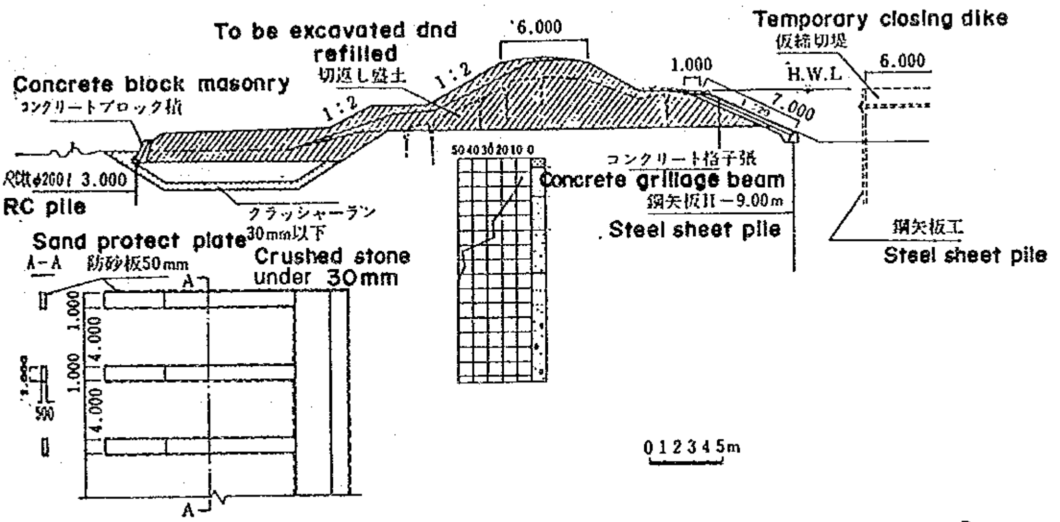


Fig.5.18 N VALUE BEFORE AND AFTER IMPROVED BY SAND COMPACTION PILE



閖上上堤防災害復旧断面図[1] Yuriage Kami Earth Dike



種次第一堤防災害復旧断面図[1] Tanetsugi Daiichi Earth Dike

Fig. 5.19 REHABILITATED SECTION OF EARTH DIKES

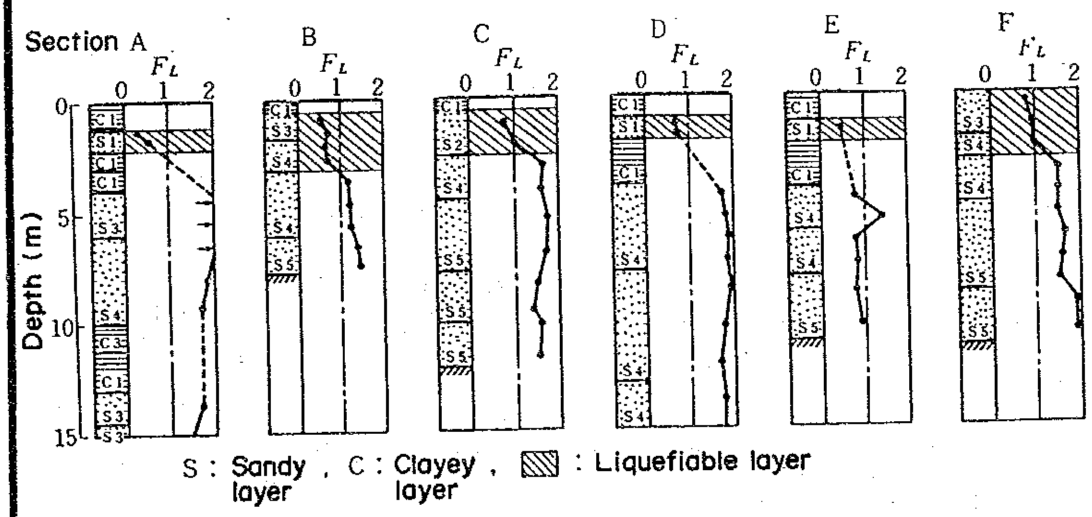


Fig. 5.20 LIQUEFACTION ANALYSIS ON HORIZONTAL GROUND

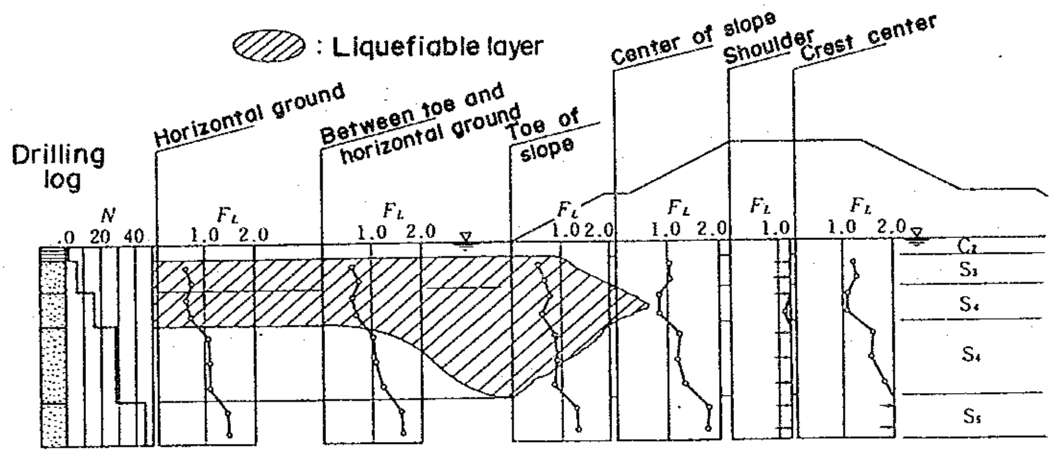
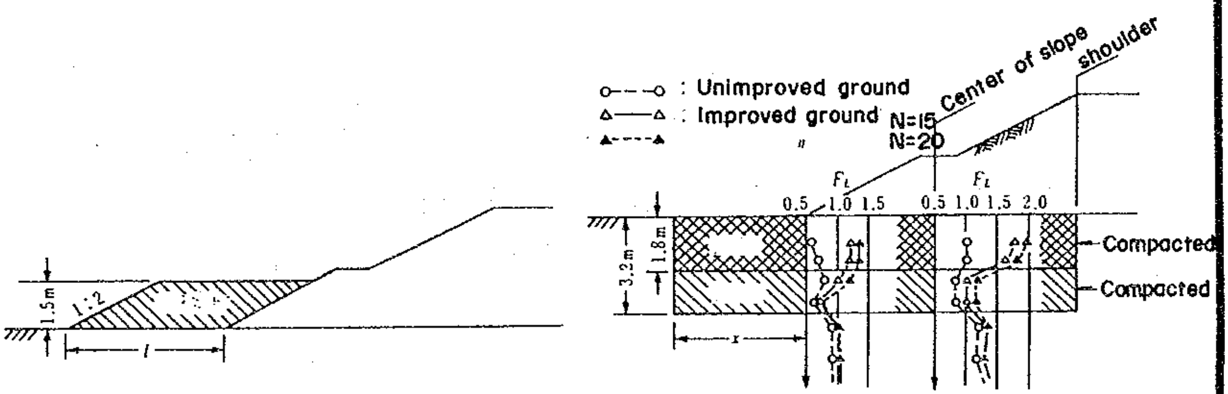


Fig.5.21 LIQUEFACTION ANALYSIS IN TWO DIMENSIONAL SECTION (B SECTION)



(a) Counterweight fill

(b) Dynamic consolidation

Fig. 5.22 STUDIED COUNTERMEASURE RANGE (B SECTION)

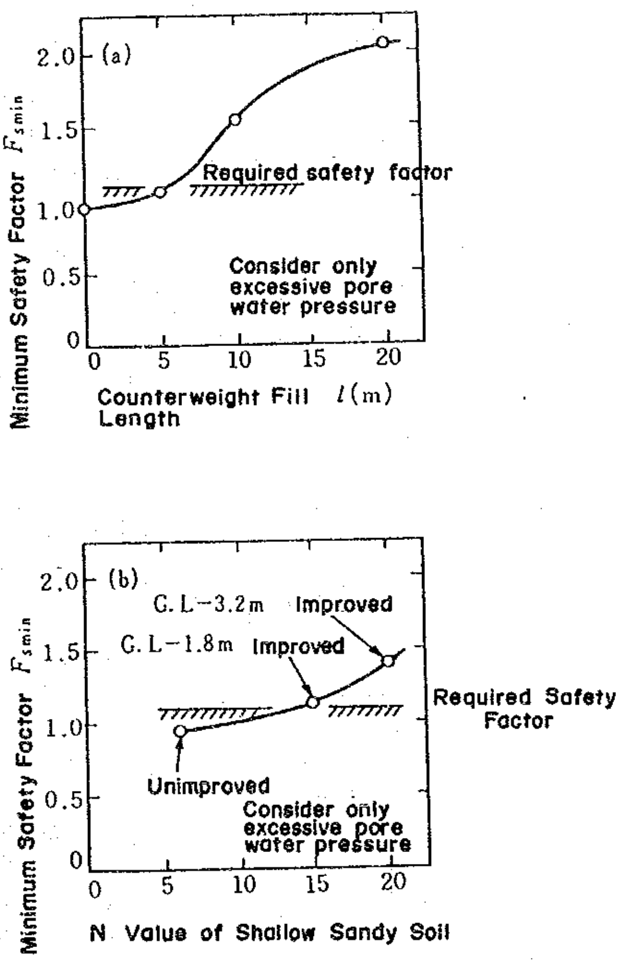
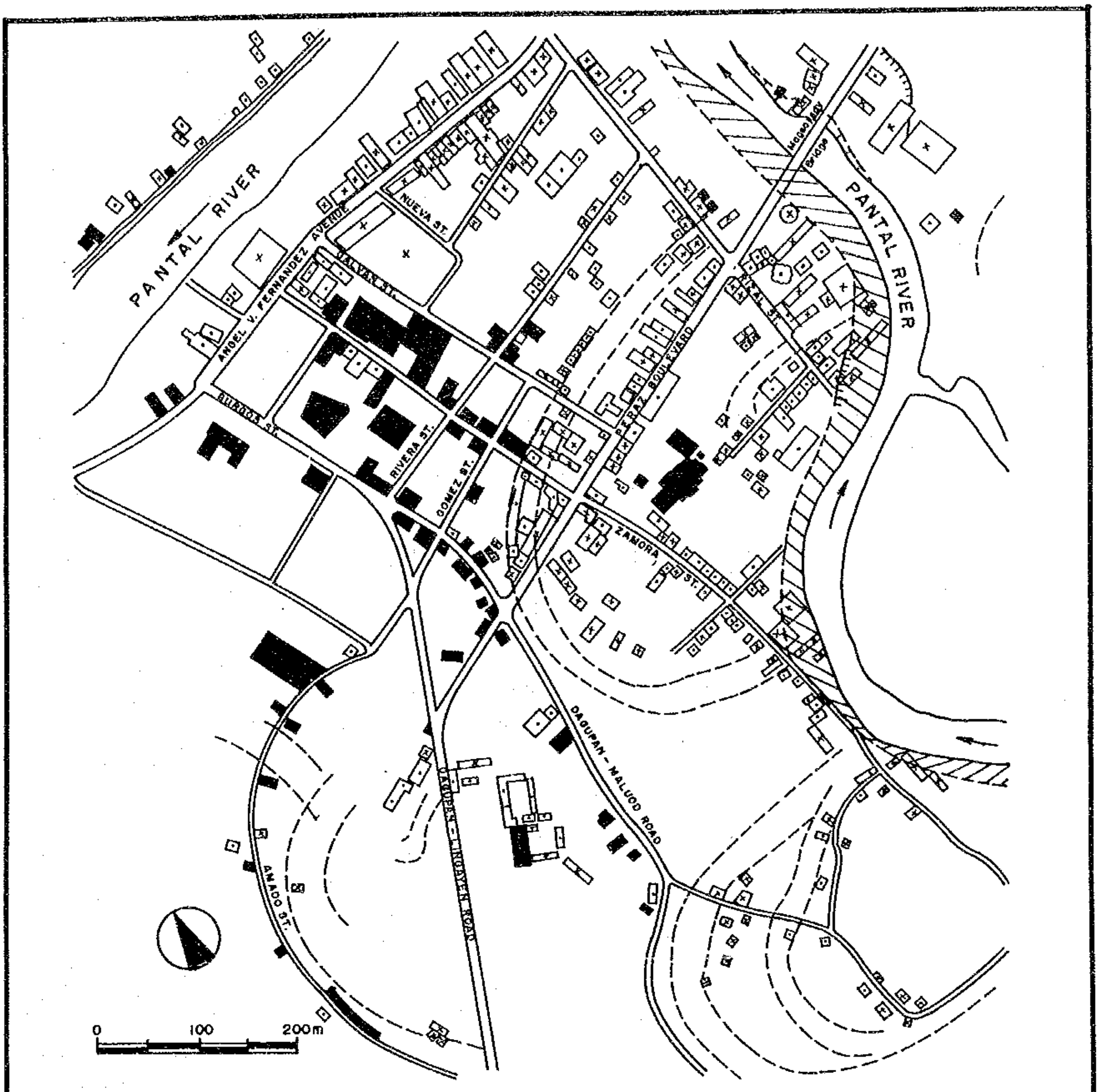


Fig. 5.23 EFFECTIVENESS OF COUNTERMEASURE
(B SECTION)

Fig. 6.1 LOCATION MAP OF GEOLOGICAL SURVEY

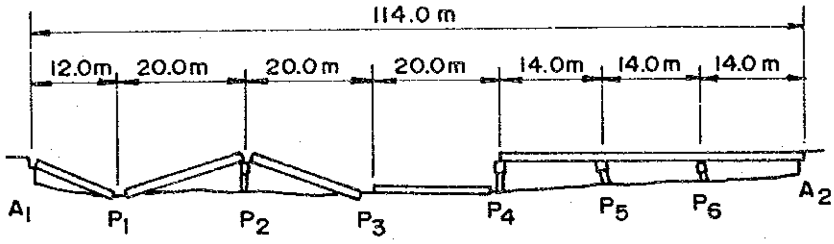


Source : Philippine Institute of Volcanology and Seismology

LEGEND

- TOTALLY DAMAGED BUILDING
- PARTIALLY DAMAGED BUILDING
- UNDAMAGED BUILDING
- ANCIENT RIVER CHANNEL
- RECLAIMED RIVERINE AREA
- ROAD

Fig. 6.2 AFFECTED AND UNAFFECTED BUILDINGS BY LIQUEFACTION IN DAGUPAN CITY DURING THE 16 JULY 1990 NORTHERN LUZON EARTHQUAKES



Simple Steel I Beam & RCDG Combination

Simple RCDG

A_1 & A_2 : Pile Bent Type

$P_1 \sim P_5$: Wall Type

Fig. 6.3 SKETCH OF DAMAGED MAGSAYSAY BRIDGE

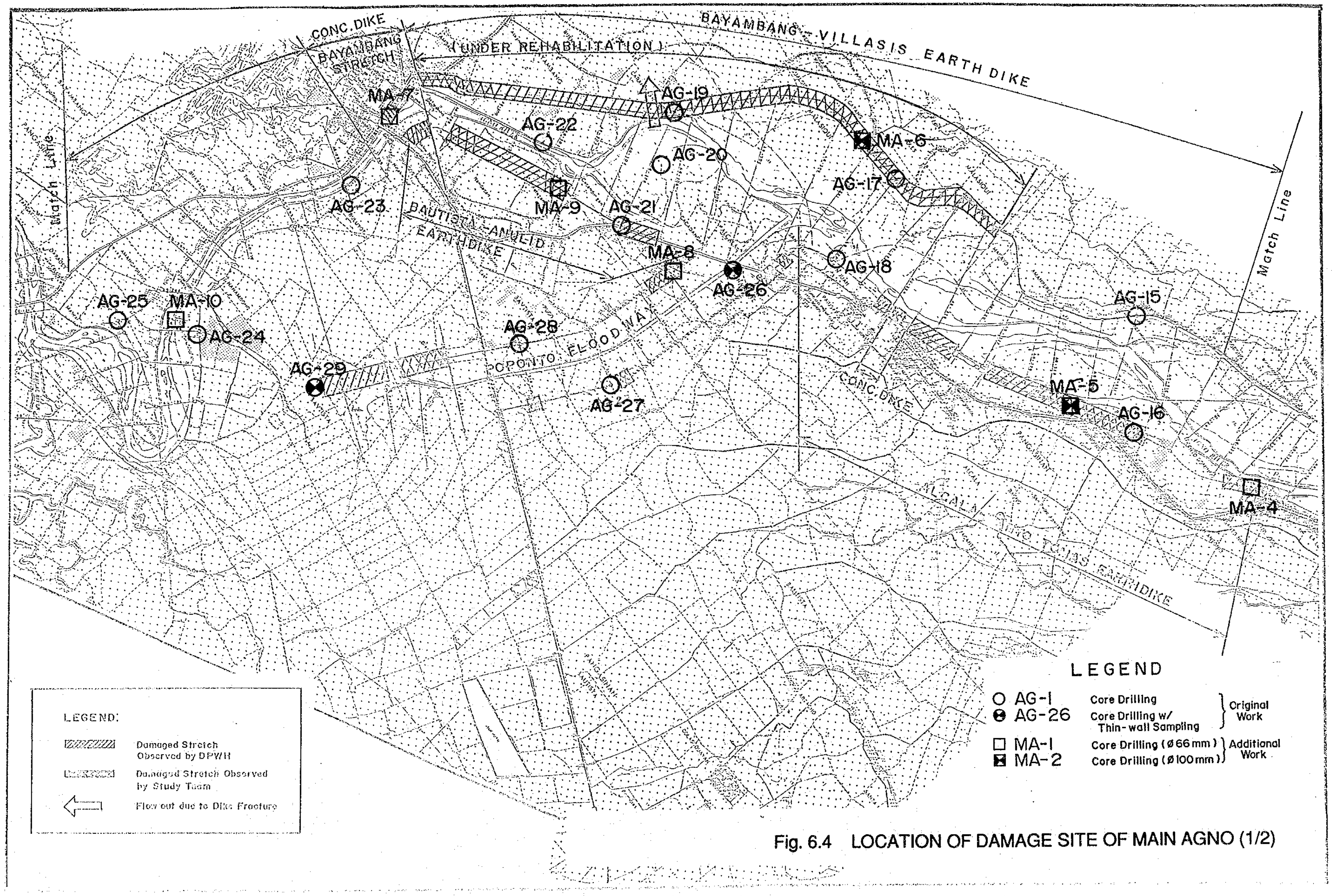


Fig. 6.4 LOCATION OF DAMAGE SITE OF MAIN AGNO (1/2)

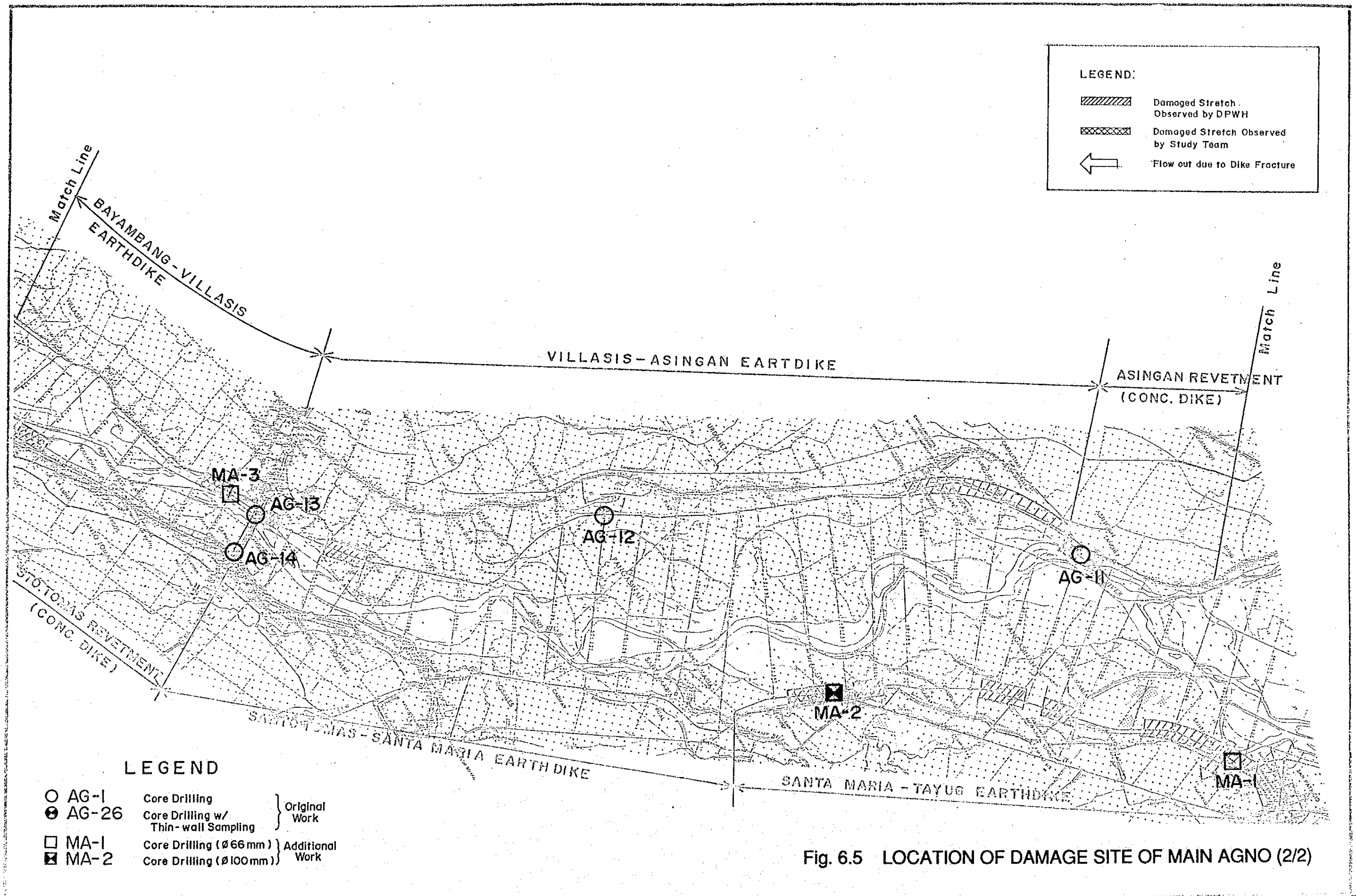


Fig. 6.5 LOCATION OF DAMAGE SITE OF MAIN AGNO (2/2)

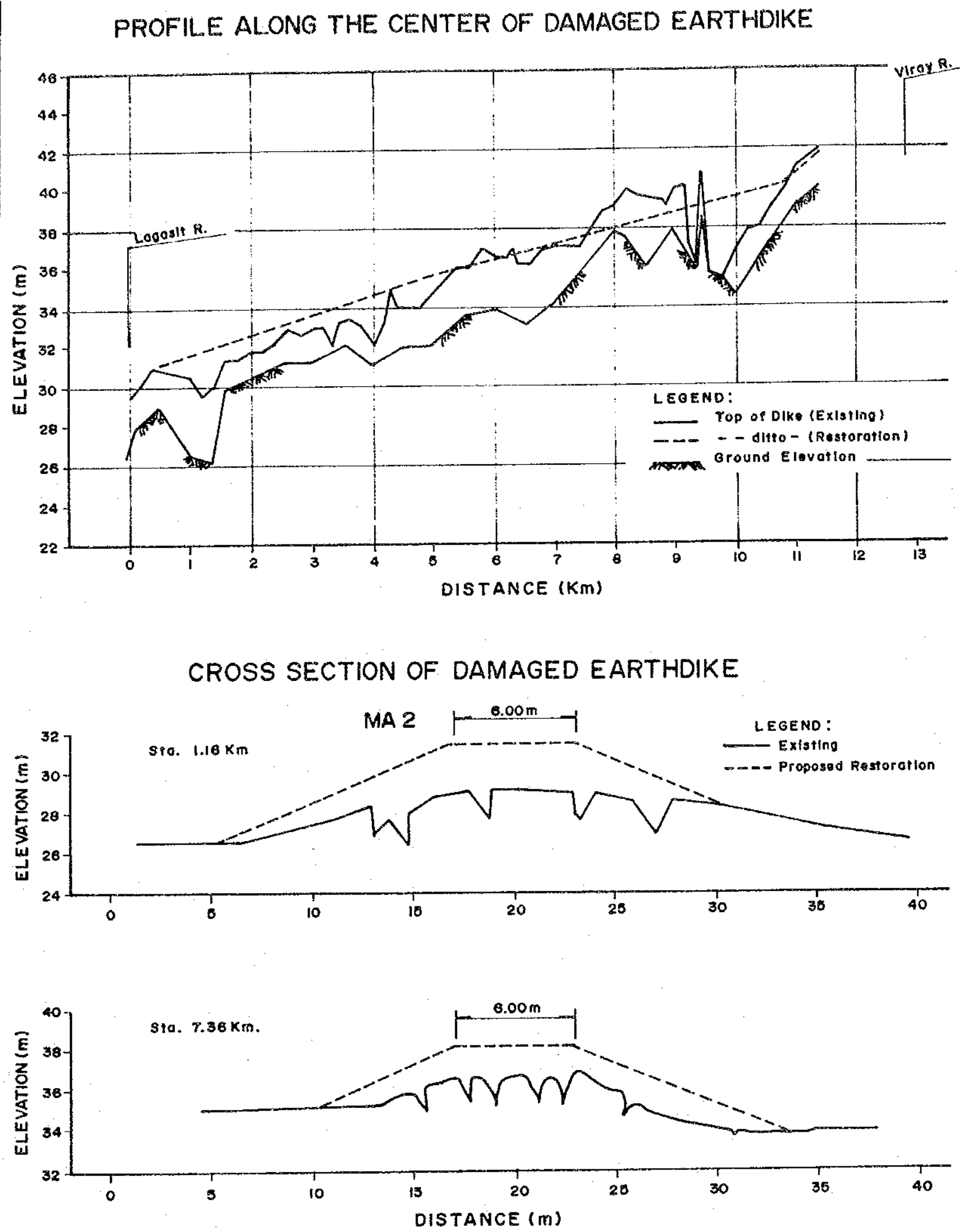


Fig. 6.6 DAMAGED LEFT EARTHDIKE OF MAIN AGNO (Sta. Maria - Tayug)

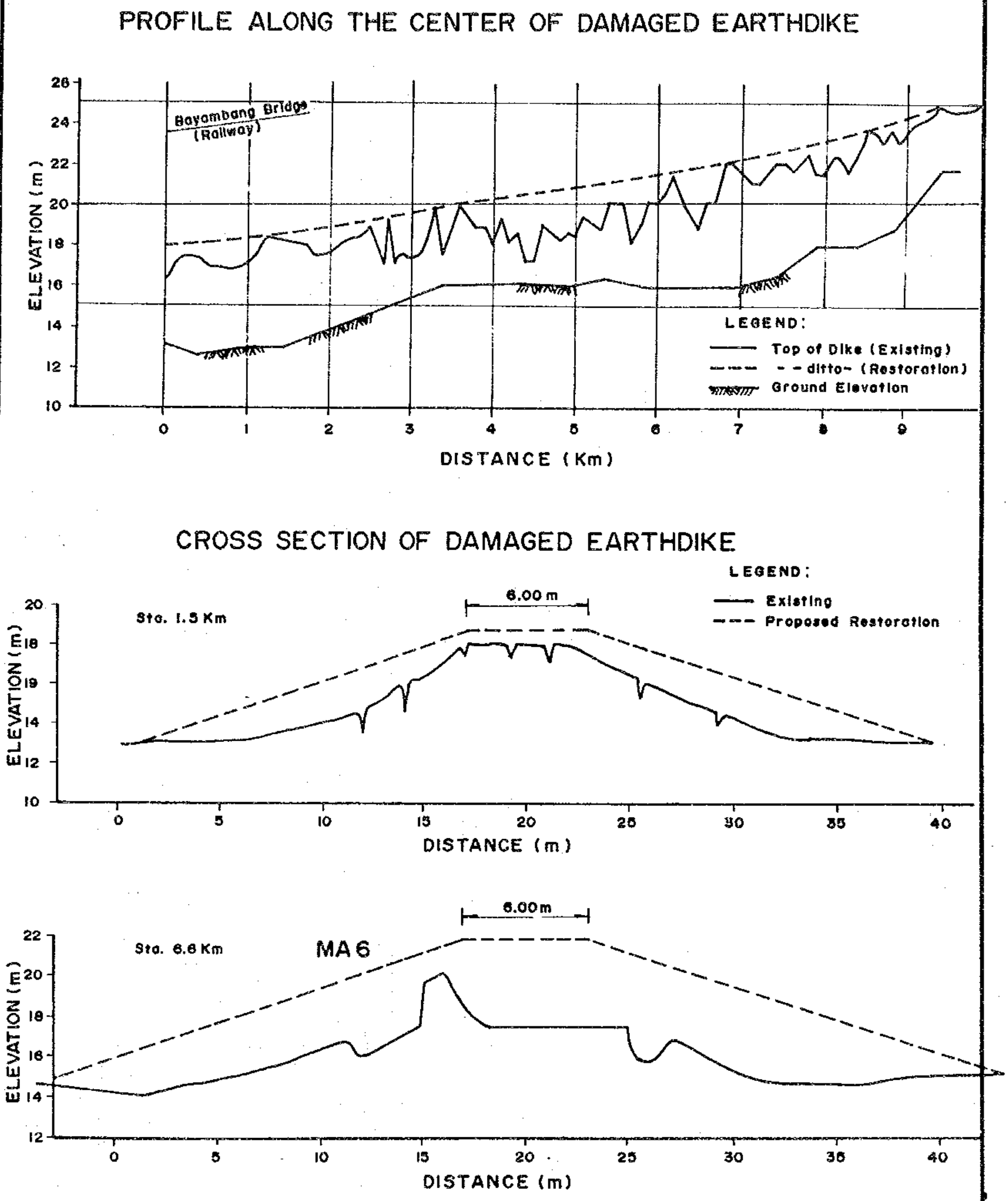


Fig. 6.7 DAMAGED RIGHT EARTHDIKE OF MAIN AGNO
(Bayambang - Carmen Br.)

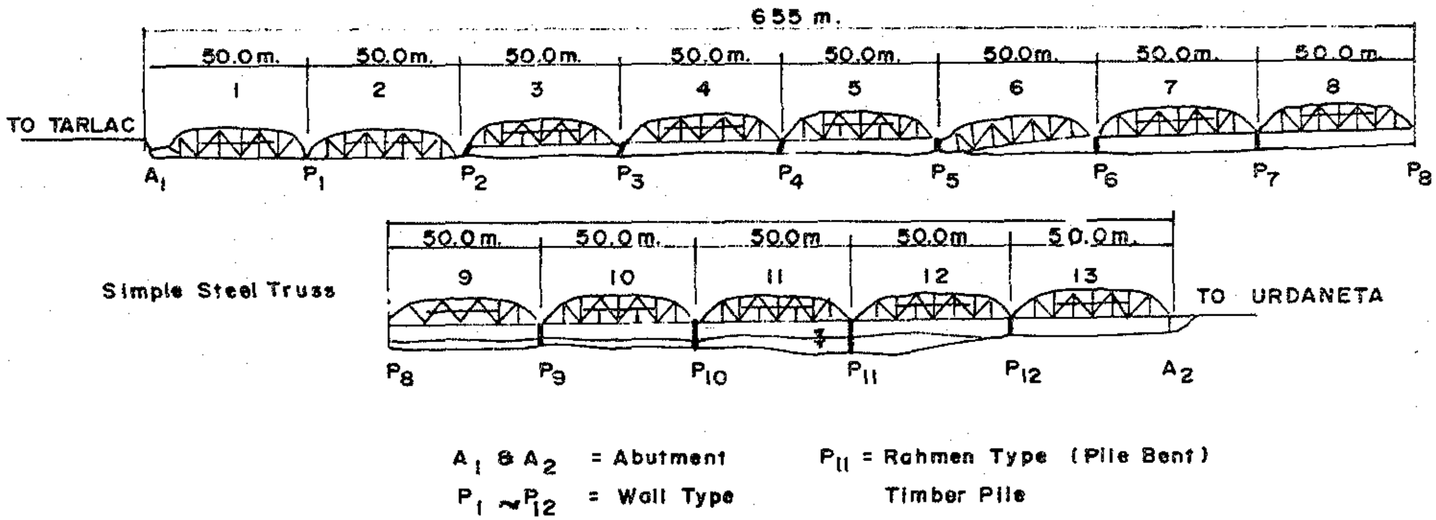
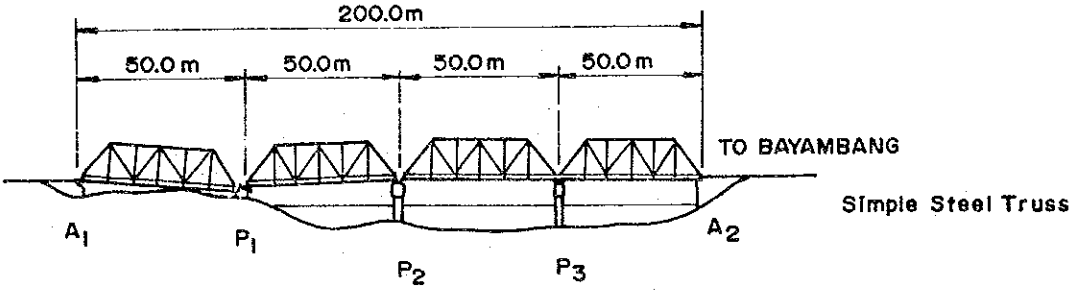


Fig. 6.8 SKETCH OF DAMAGED SISON BRIDGE



A_1 & A_2	:	Pile Bent Type
P_1	:	Pile Bent
P_2	:	Multi Span
P_3	:	Wall Type

Fig. 6.9 SKETCH OF DAMAGED CALVO BRIDGE

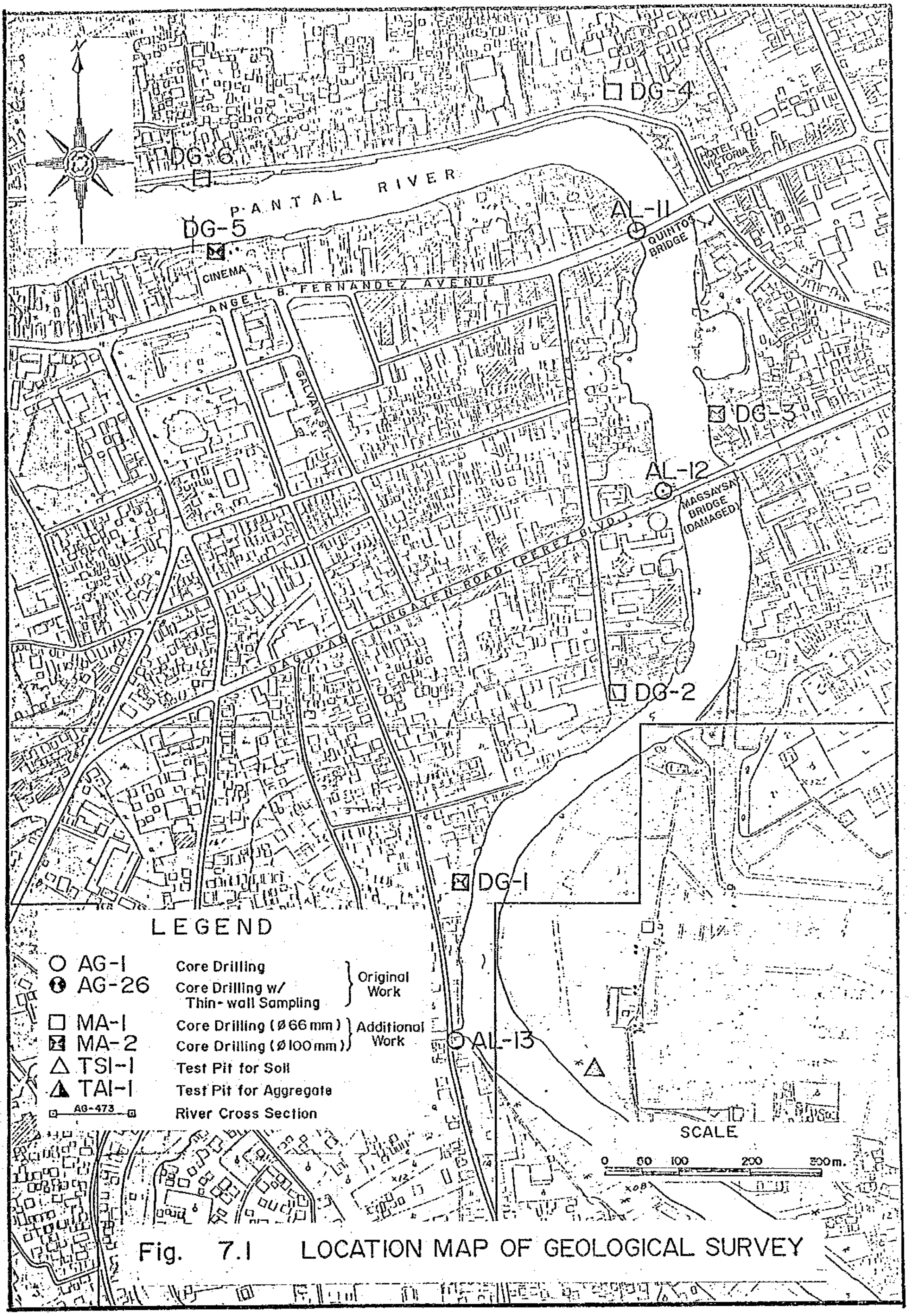


Fig. 7.1 LOCATION MAP OF GEOLOGICAL SURVEY

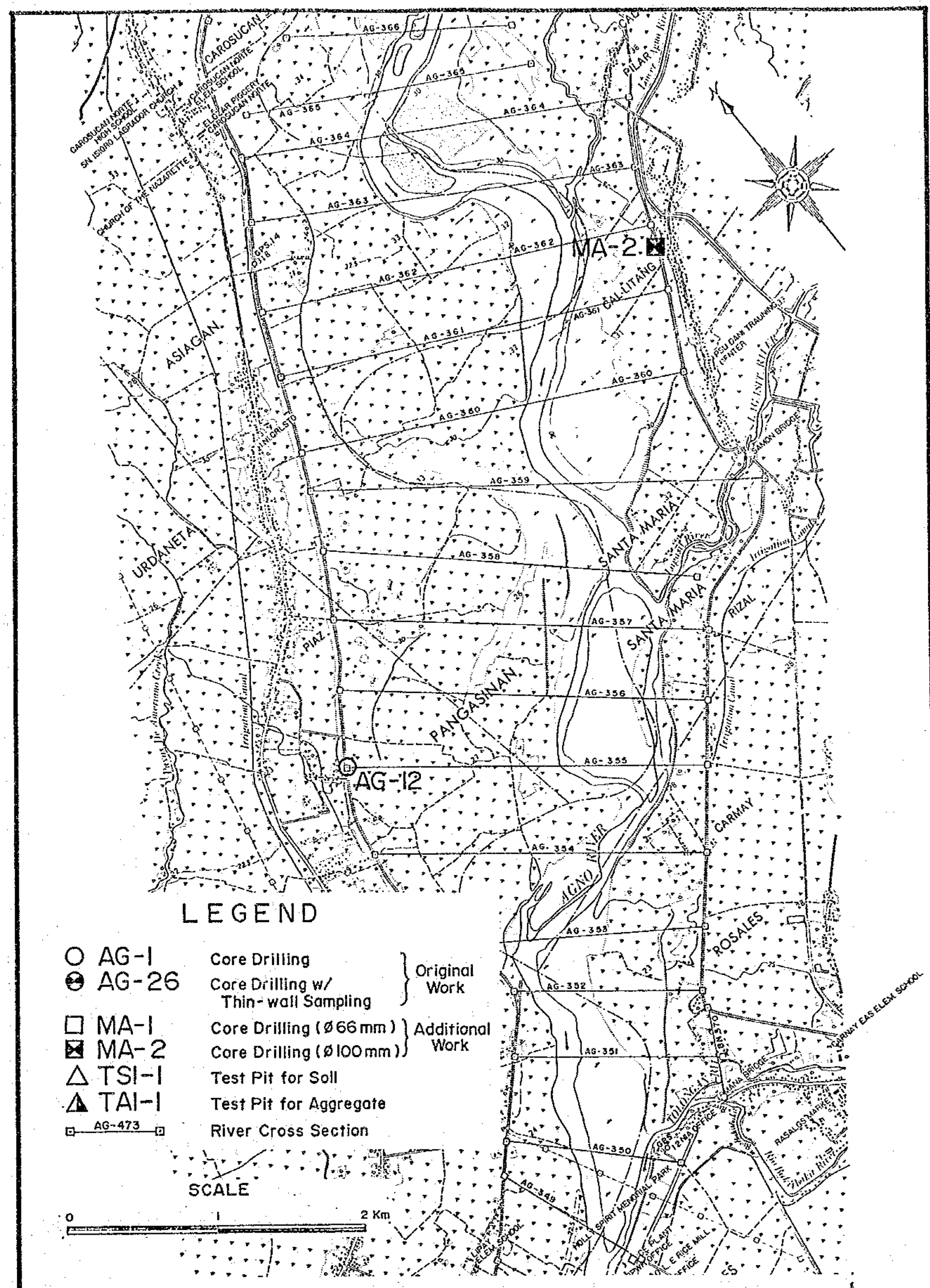


Fig. 7.2 LOCATION MAP OF GEOLOGICAL SURVEY

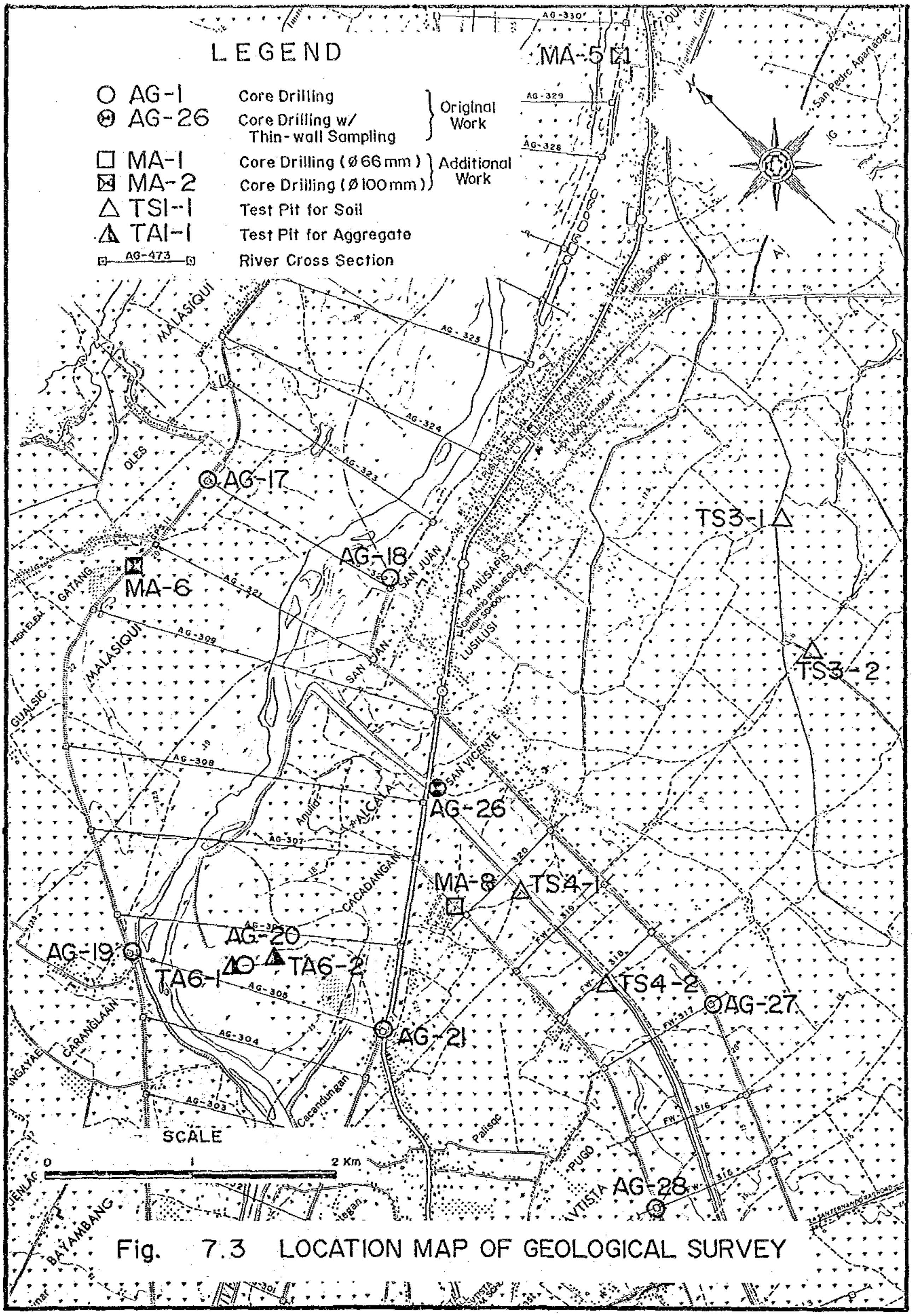


Fig. 7.3 LOCATION MAP OF GEOLOGICAL SURVEY

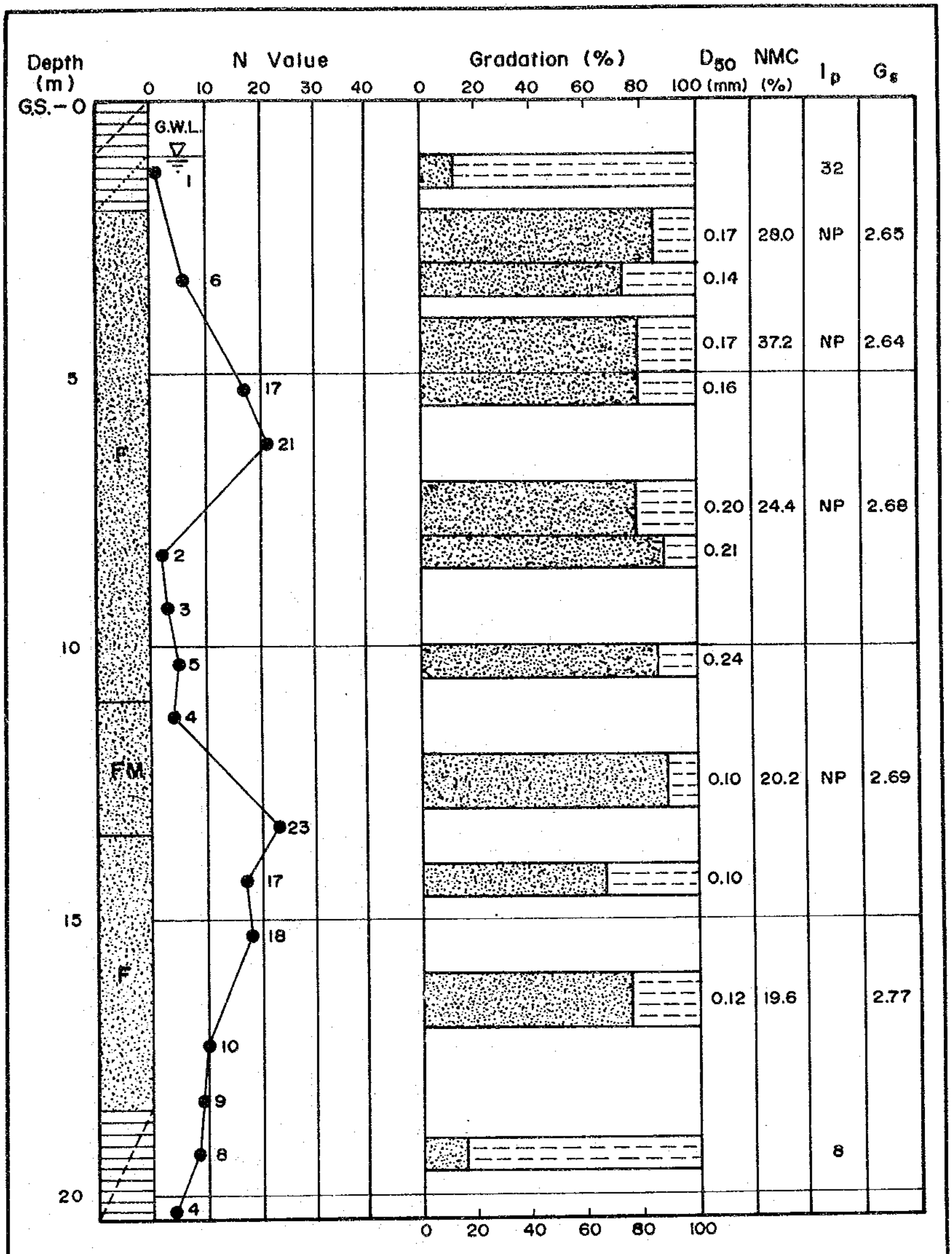


Fig. 7.4 GEOTECHNICAL DATA OF DG-1

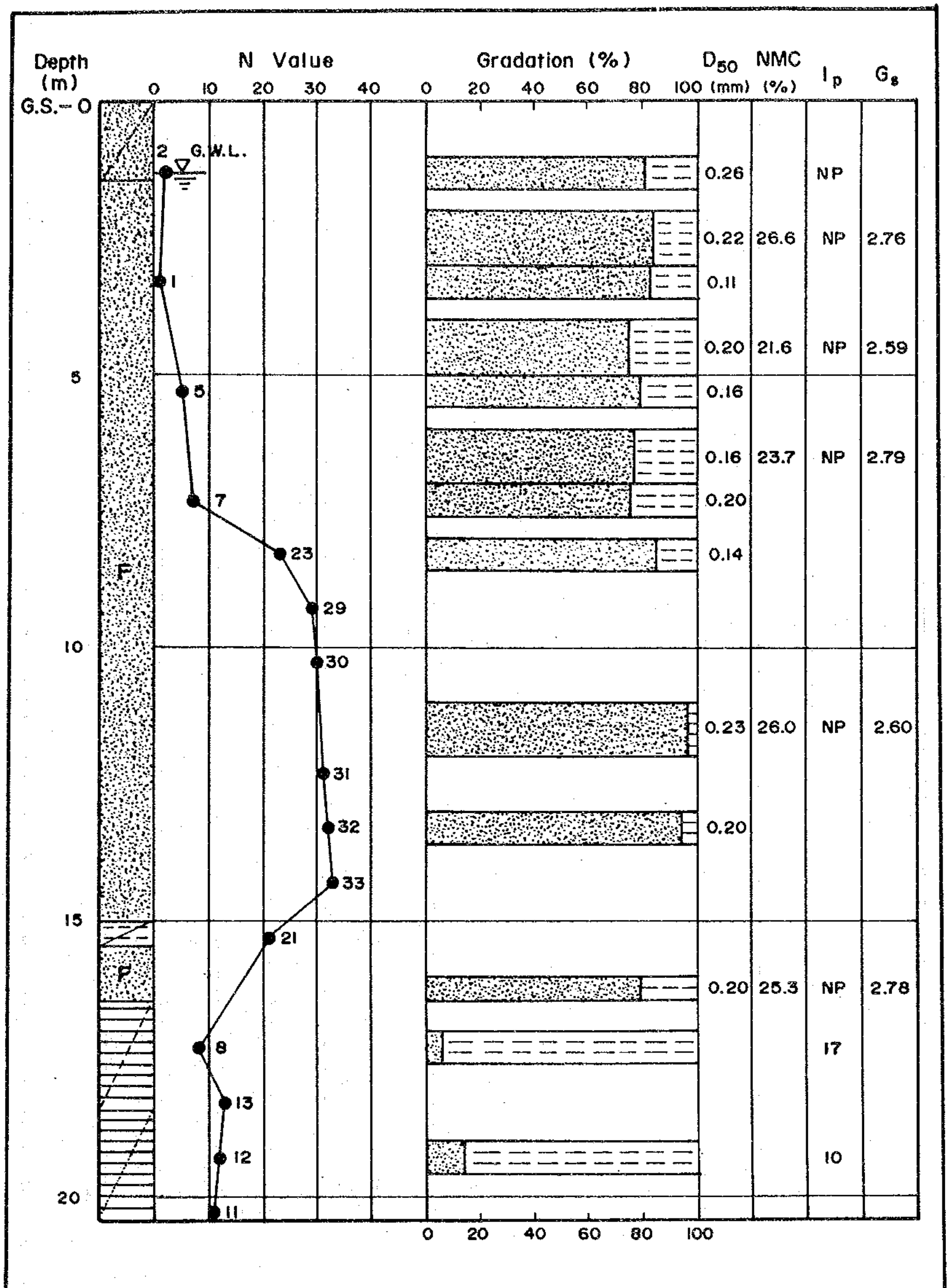


Fig. 7.5 GEOTECHNICAL DATA OF DG-3

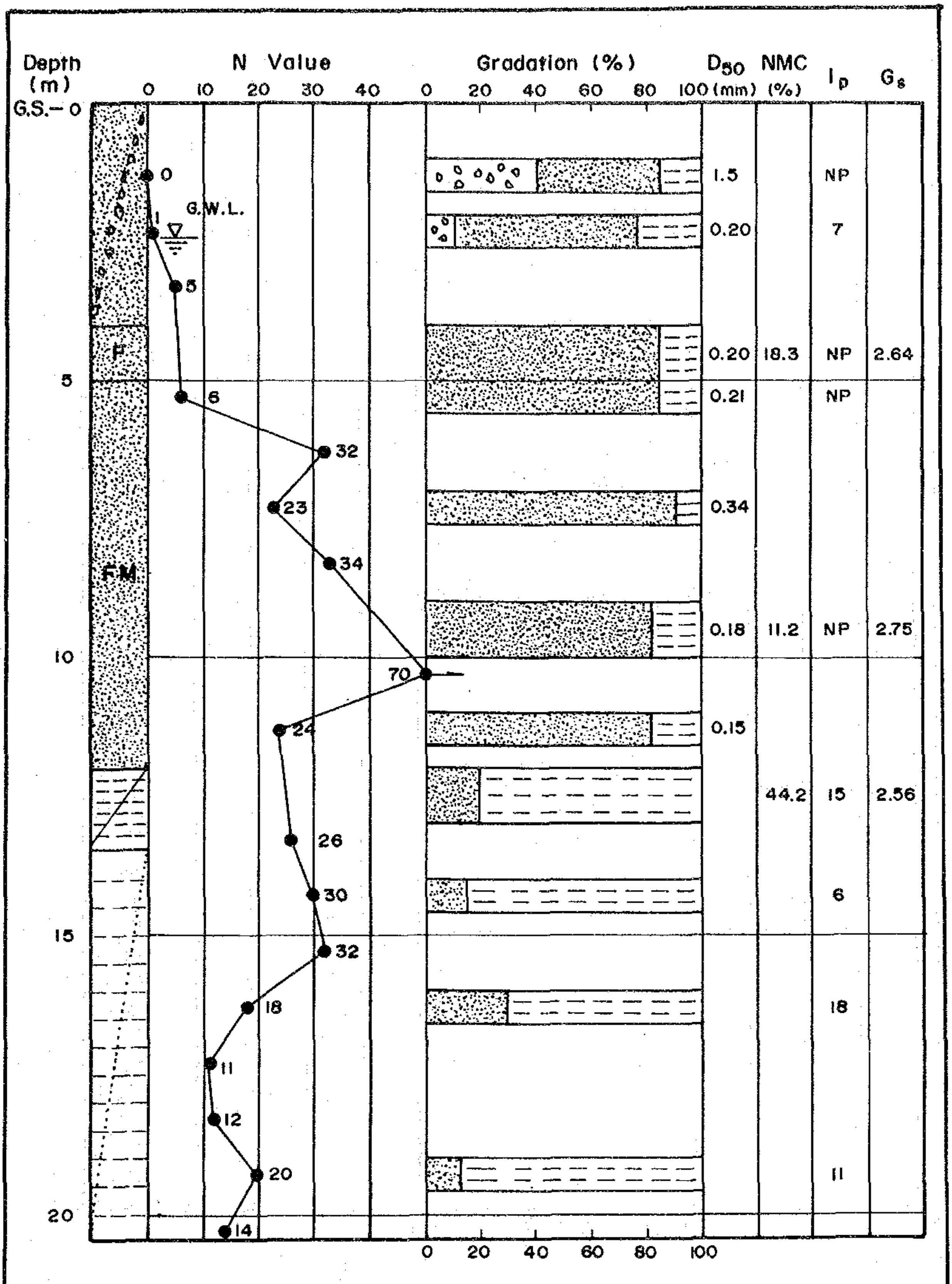


Fig. 7.6 GEOTECHNICAL DATA OF DG-5

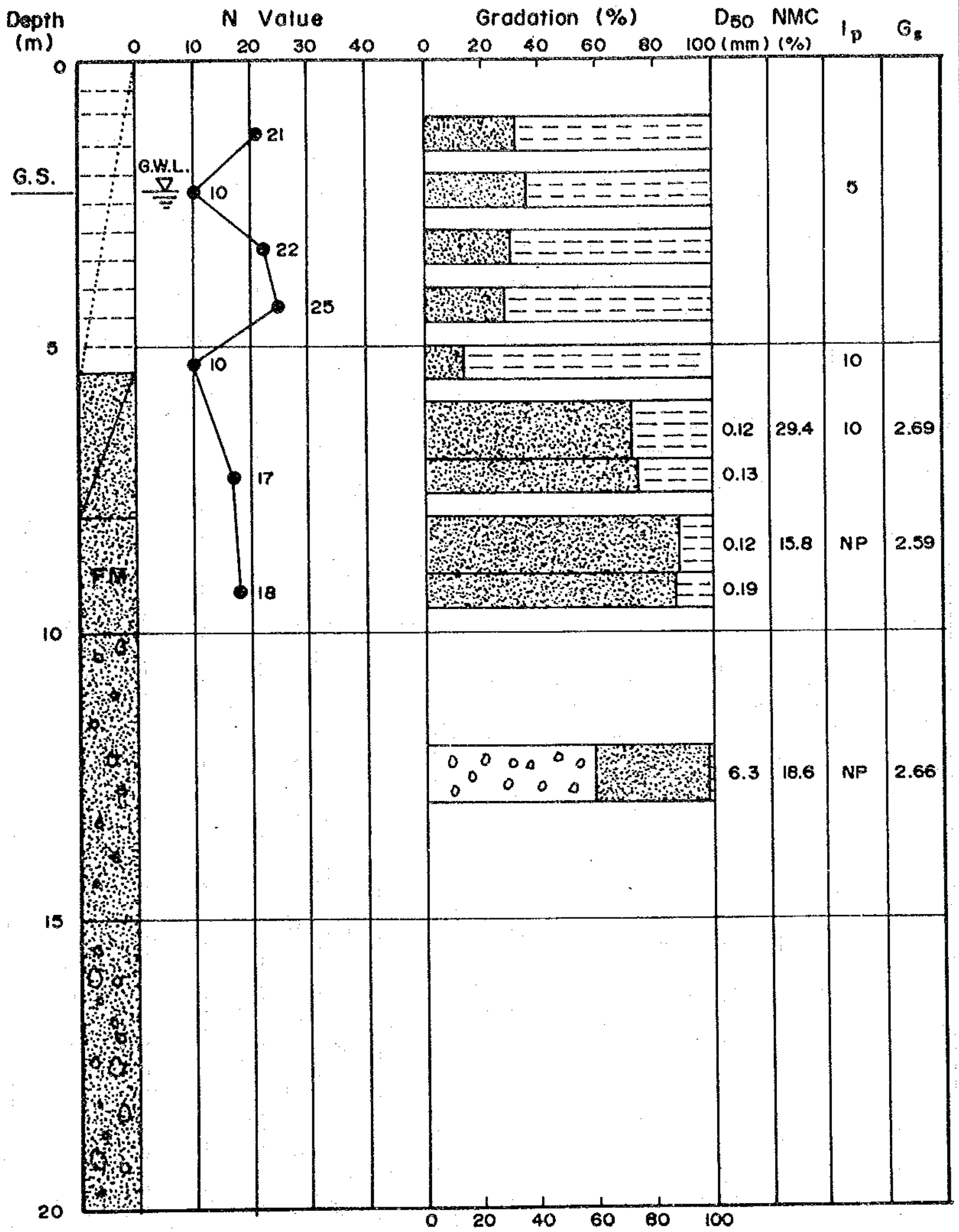


Fig. 7.7 GEOTECHNICAL DATA OF MA-2

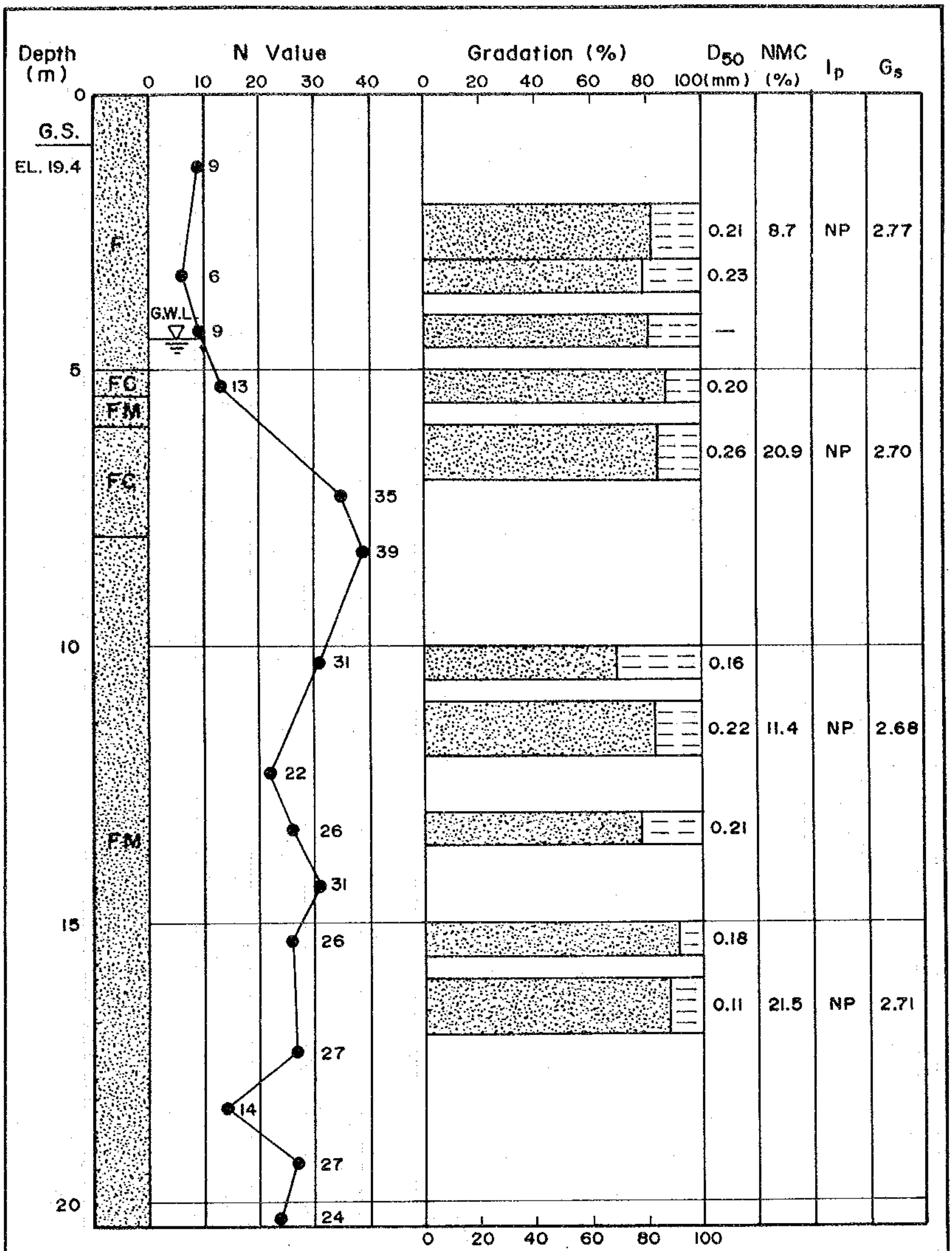


Fig. 7.8 GEOTECHNICAL DATA OF MA-5

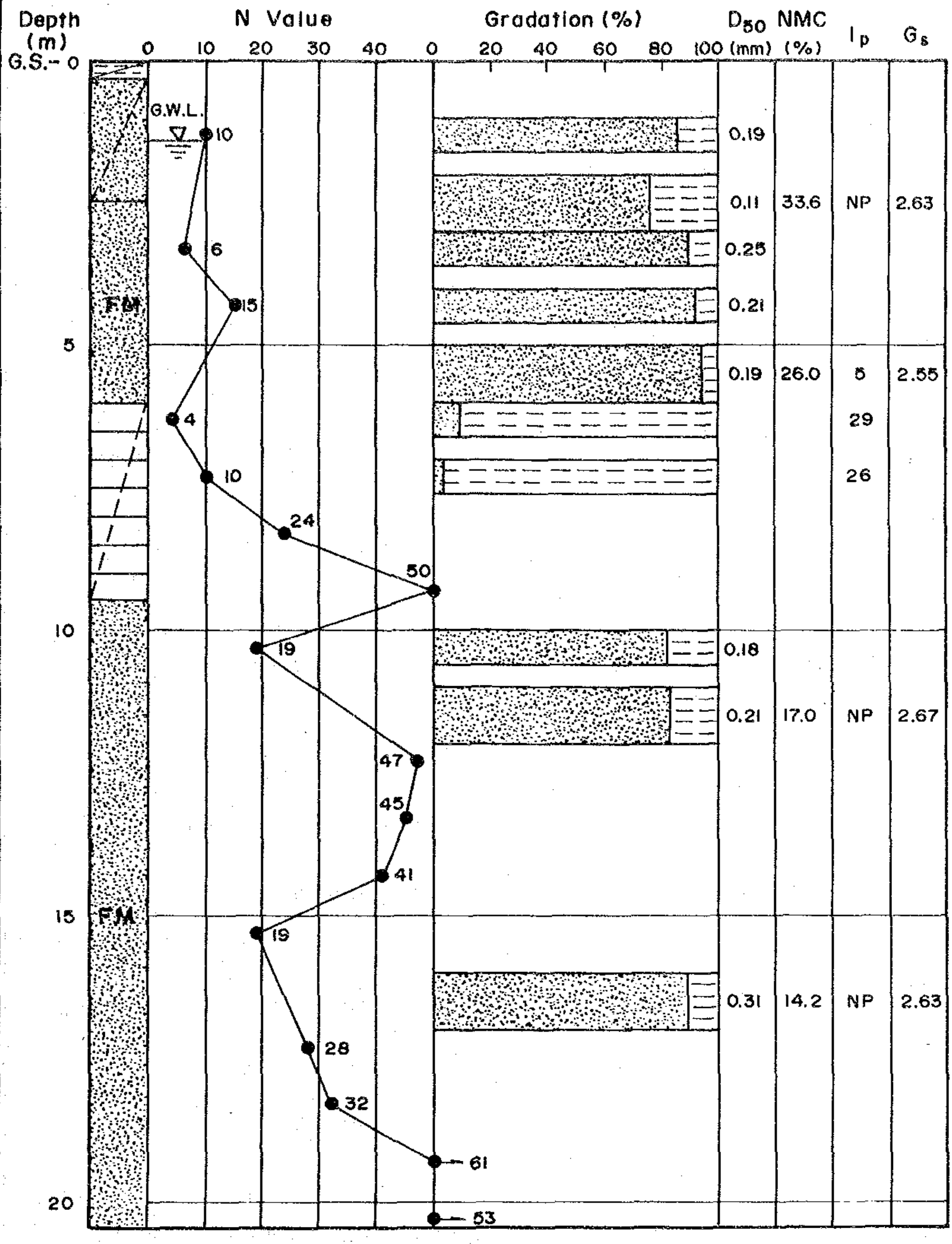


Fig. 7.9 GEOTECHNICAL DATA OF MA-6

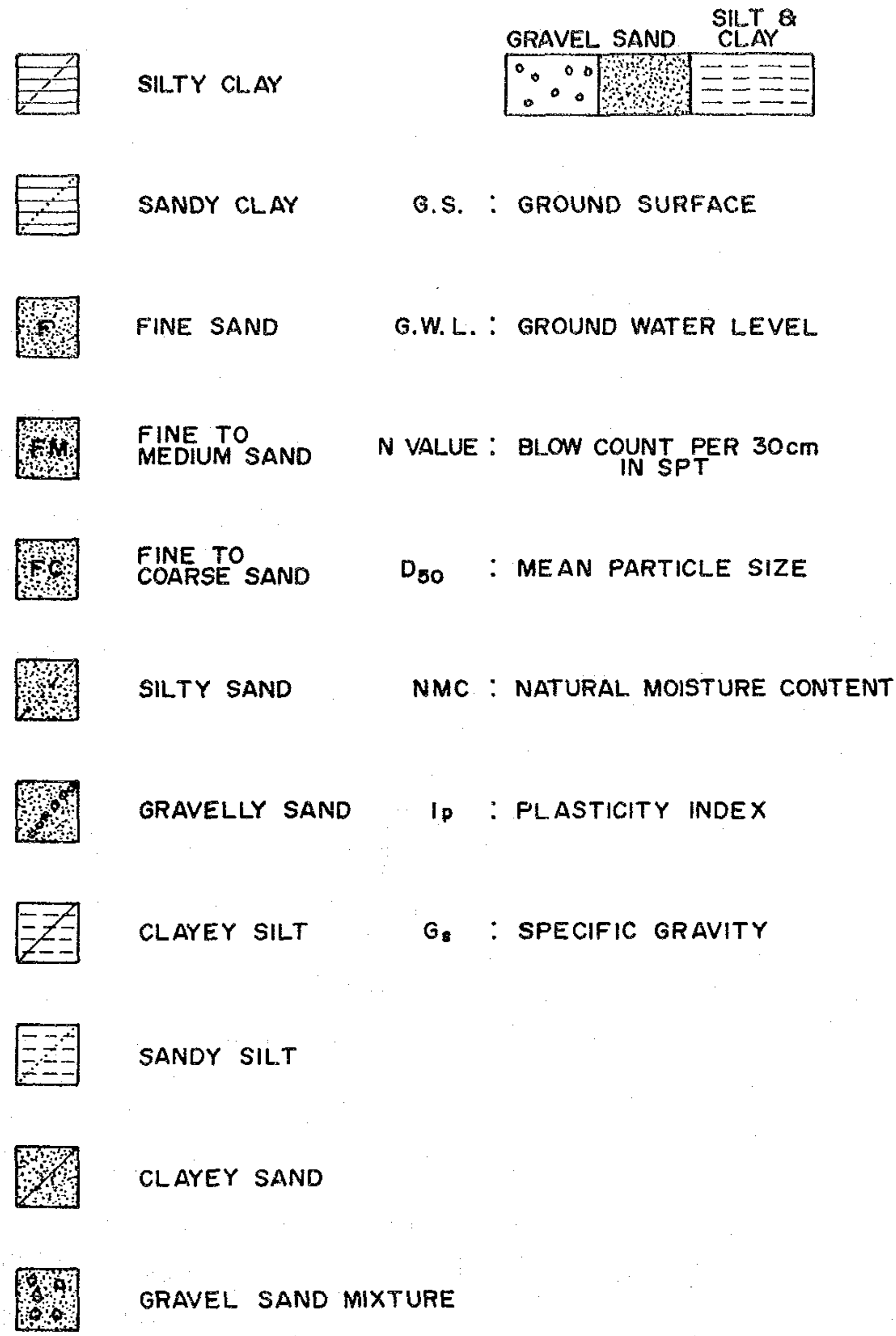


Fig. 7.10 LEGEND

GRADATION ANALYSIS
(ANALYSE GRANULOMÉTRIQUE)

FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L' ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	**DG - I** (m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY (POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												

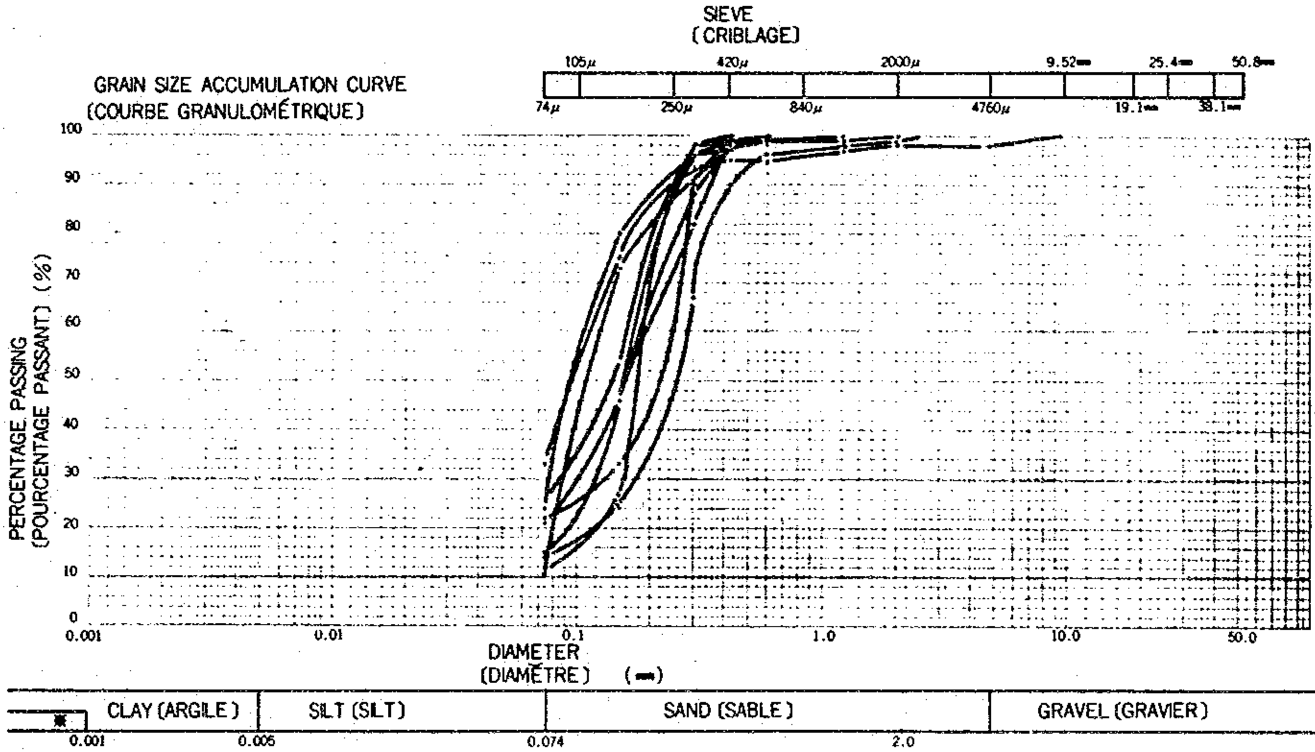


Fig. 7.11 GRADATION CURVE OF DG - I

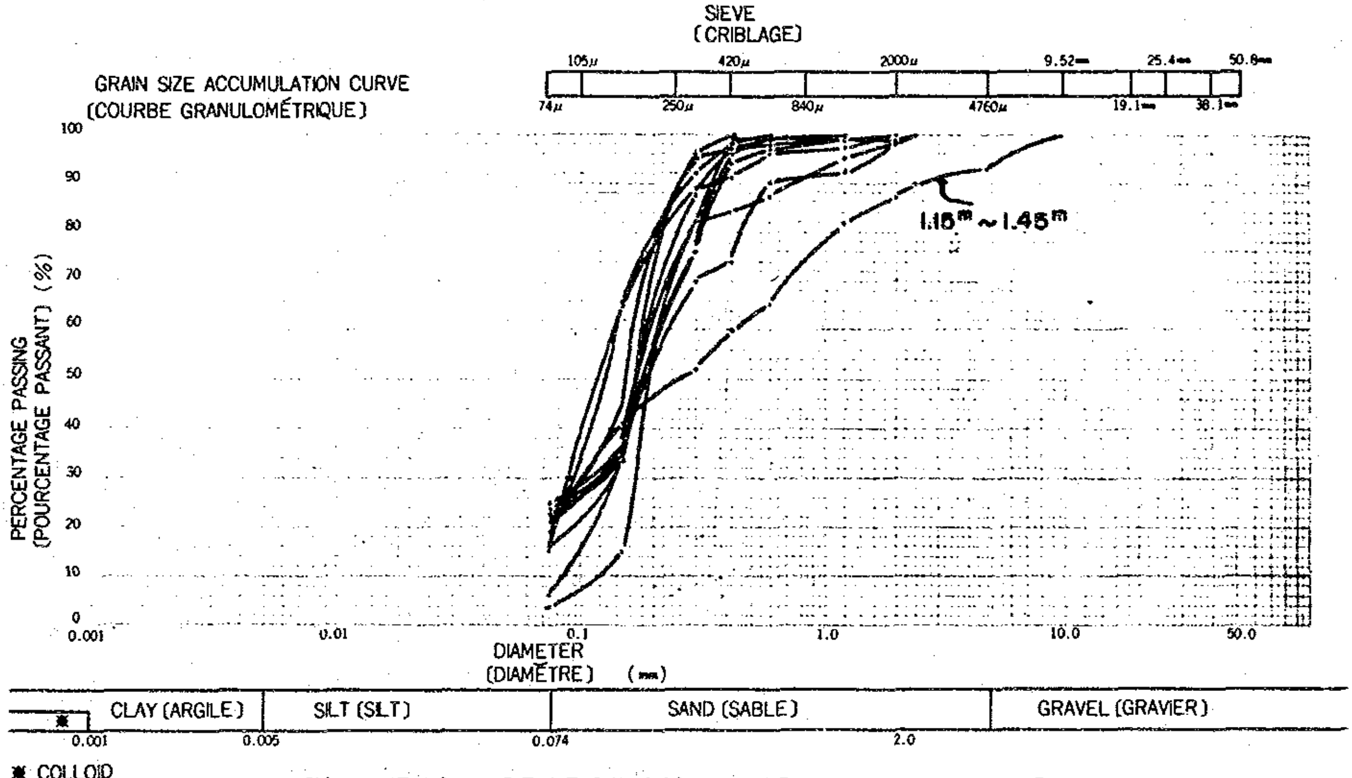
PROPORTION (PROPORTION)				
4.76mm <	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
4.76 ~ 2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
2.00 ~ 0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
0.42 ~ 0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
0.074 ~ 0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D' UNIFORMITÉ)	
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)			FOR REPORTING (POUR LE RAPPORT)
NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L' ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	**DG - 3** (m~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY (POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING(%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE(mm) (GRANULOMÉTRIE)												
	TOTAL PASSING(%) (TOTAL PASSANT)												



✱ COLLOID (COLLOÏDE)

Fig. 7.12 GRADATION CURVE OF DG - 3

PROPORTION (PROPORTION)				
	4.76mm <	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
	4.76~2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
	2.00~0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
	0.42~0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
	0.074~0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D' UNIFORMITÉ)	
	0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

N. K. FORM NO. 002 (1975)

GRADATION ANALYSIS
(ANALYSE GRANULOMÉTRIQUE)

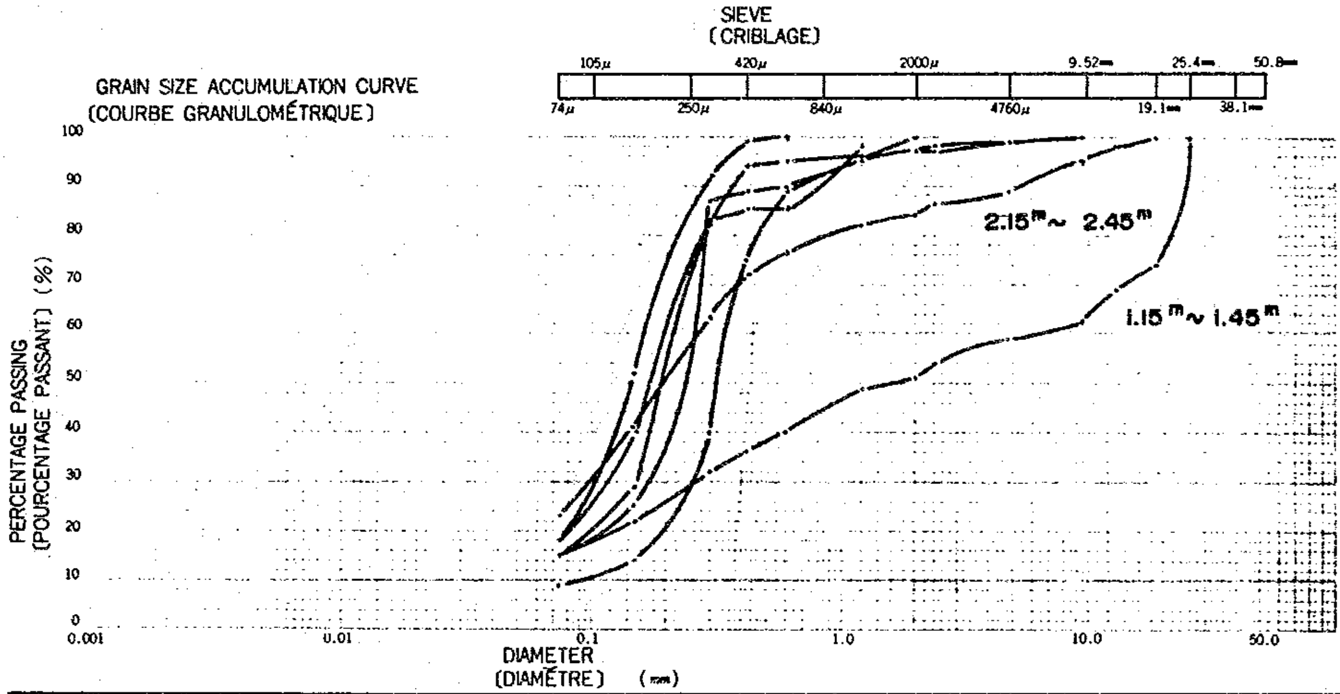
FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR)	**DG - 5** (m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY (POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												



*	CLAY (ARGILE)	SILT (SILT)	SAND (SABLE)	GRAVEL (GRAVIER)
0.001	0.005	0.074	2.0	

* COLLOID (COLLOÏDE)

Fig. 7.13 GRADATION CURVE OF DG - 5

PROPORTION (PROPORTION)	4.76mm <	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
	4.76 ~ 2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
	2.00 ~ 0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
	0.42 ~ 0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
	0.074 ~ 0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
	0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

N. K. FORM NO. 002 (1975)

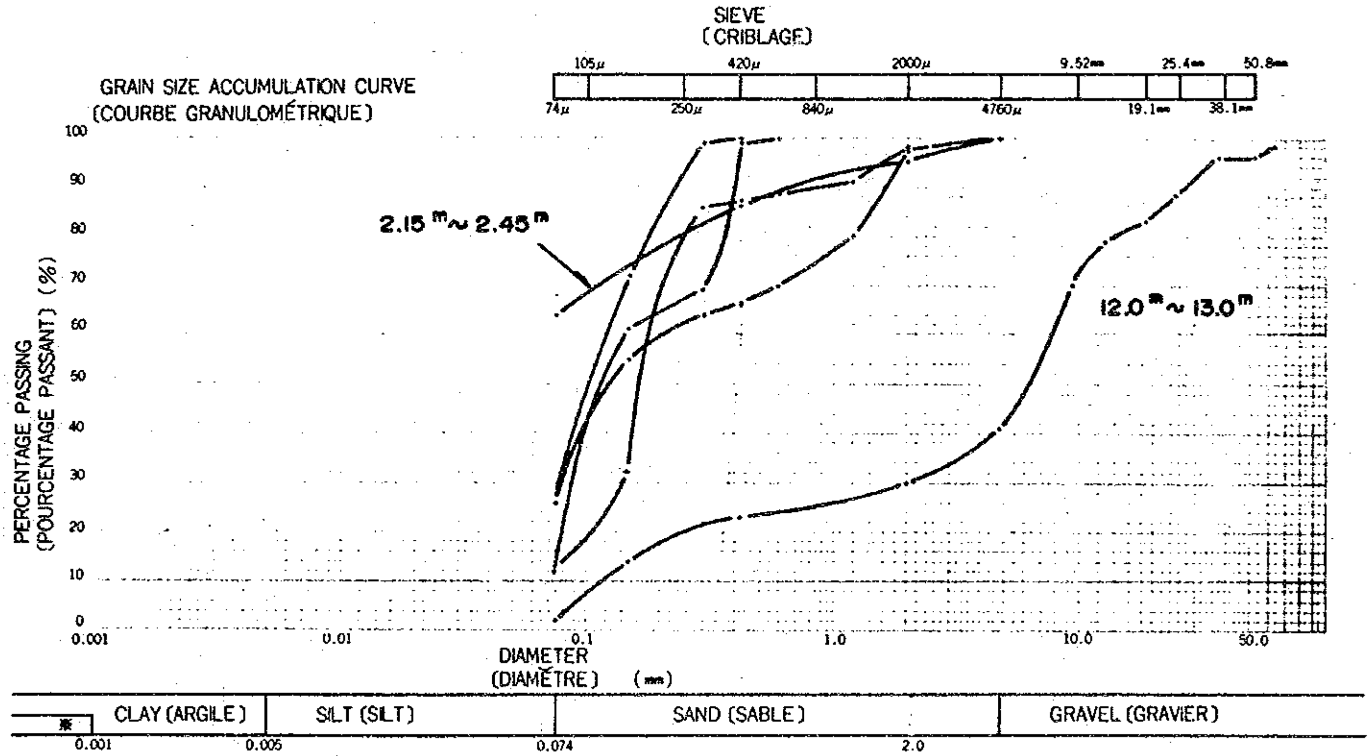
GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)	FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L' ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	**MA - 2** (m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY (POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING(%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE(mm) (GRANULOMÉTRIE)												
	TOTAL PASSING(%) (TOTAL PASSANT)												



* COLLOID (COLLOÏDE)

Fig. 7.14 GRADATION CURVE OF MA - 2

PROPORTION (PROPORTION)	4.76mm<	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
	4.76~2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
	2.00~0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
	0.42~0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
	0.074~0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D' UNIFORMITÉ)	
	0.005mm>	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

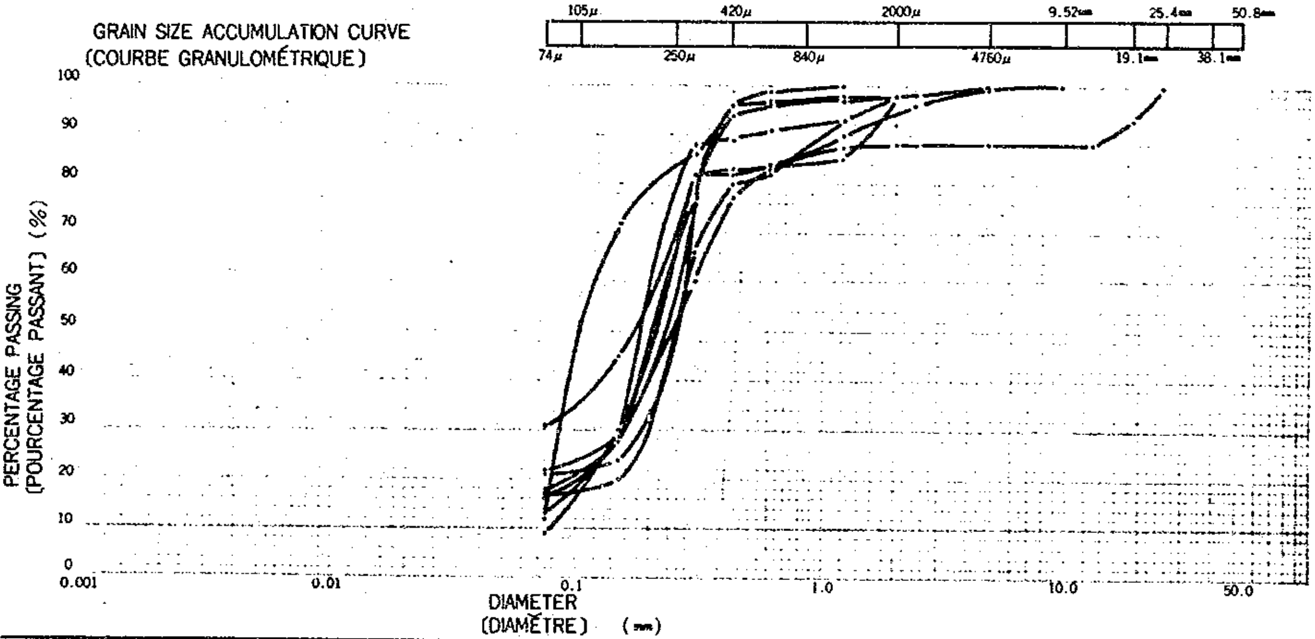
N. K. FORM NO. 002 (1975)

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)			FOR REPORTING (POUR LE RAPPORT)
NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	Agno Flood Control	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	MA - 5 (m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY
(POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												



*	CLAY (ARGILE)	SILT (SILT)	SAND (SABLE)	GRAVEL (GRAVIER)
0.001	0.005	0.074	2.0	

* COLLOID
(COLLOÏDE)

Fig. 7.15 GRADATION CURVE OF MA - 5

PROPORTION (PROPORTION)	4.76mm <	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
	4.76 ~ 2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
	2.00 ~ 0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
	0.42 ~ 0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
	0.074 ~ 0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
	0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

N. K. FORM NO. 002 (1975)

GRADATION ANALYSIS
(ANALYSE GRANULOMÉTRIQUE)

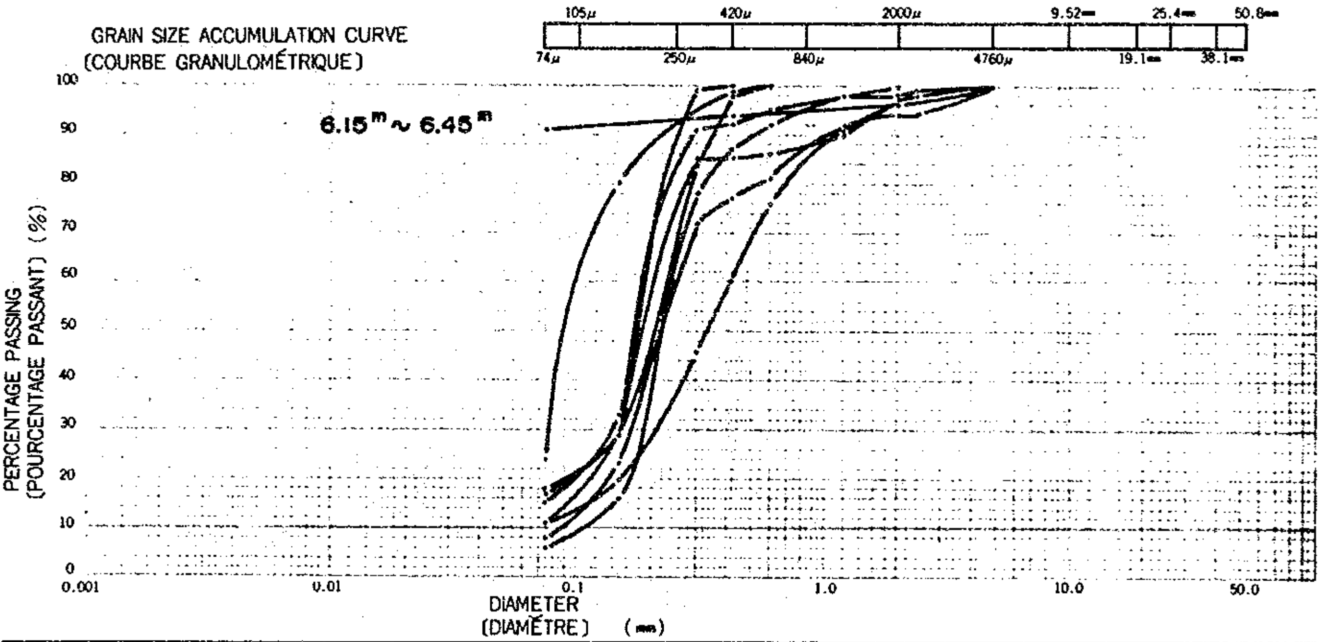
FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L' ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	**MA - 6** (m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY (POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												



* COLLOID (COLLOÏDE)

Fig. 7.16 GRADATION CURVE OF MA-6

PROPORTION (PROPORTION)				
	4.76mm <	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
	4.76~2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
	2.00~0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
	0.42~0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
	0.074~0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
	0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

N. K. FORM NO. 002 (1975)

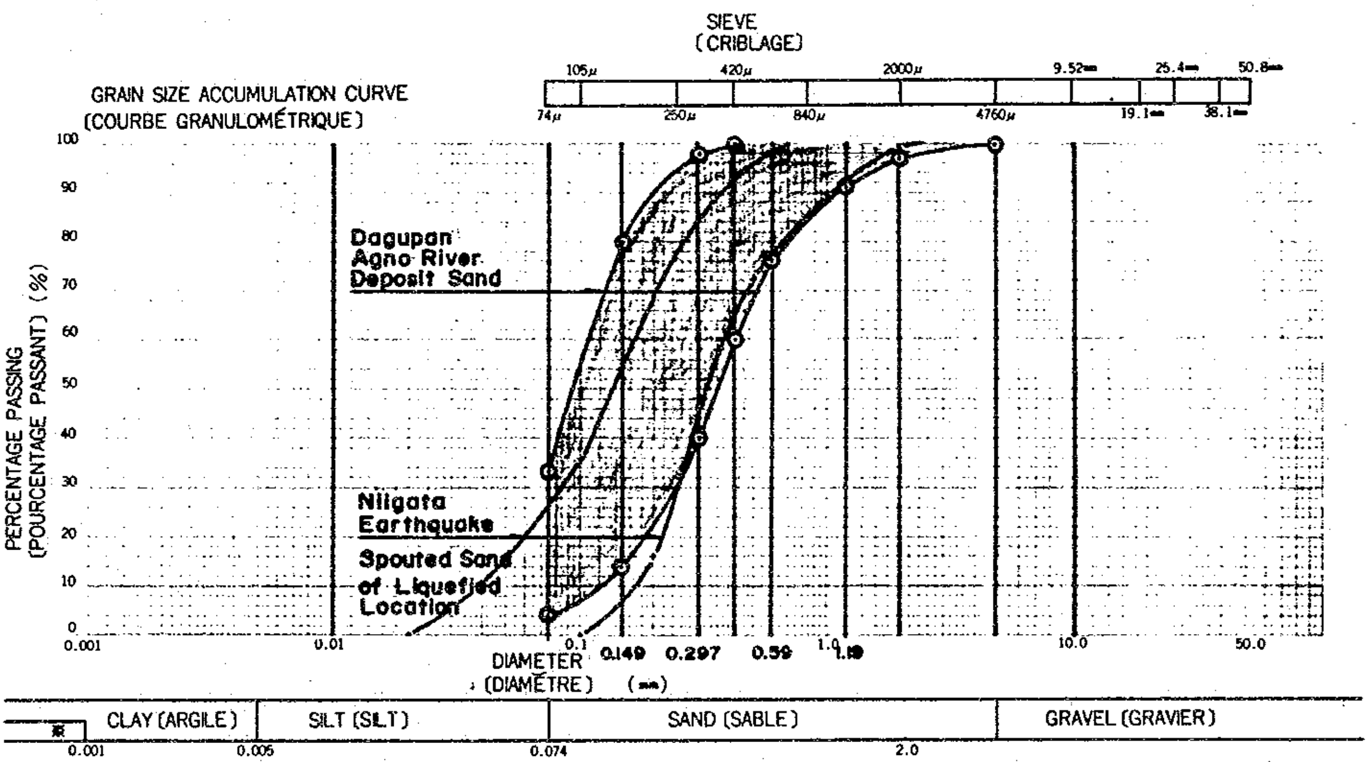
GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)	FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	(m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY
(POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING(%) (TOTAL PASSANT)												
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE(mm) (GRANULOMÉTRIE)												
	TOTAL PASSING(%) (TOTAL PASSANT)												



* COLLOID
(COLLOÏDE)

Fig. 7.17 COMPARISON BETWEEN SANDS IN STUDY AREA AND NIIGATA SAND

PROPORTION (PROPORTION)				
	4.76mm <	%	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	mm
	4.76~2.00mm	%	60% DIAMETER (DIAMÈTRE 60%)	mm
	2.00~0.42mm	%	30% DIAMETER (DIAMÈTRE 30%)	mm
	0.42~0.074mm	%	10% DIAMETER (DIAMÈTRE 10%)	mm
	0.074~0.005mm	%	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
	0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

N. K. FORM NO. 002 (1975)

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)			FOR REPORTING (POUR LE RAPPORT)
NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L' ENQUÊTE ET LOCALITÉ)	**Agno Flood Control**	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L ÉCHANTILLON ET PROFONDEUR)	(m ~ m)	TESTED BY (ESSAI PAR)	

PARTICLE SIZE & WEIGHT PERCENTAGE OF PARTICLES UNDER THE SIZE
(DIMENSION DES PARTICULES ET POURCENTAGE DE POIDS DES PARTICULES DE DIMENSION INFÉRIEURE AUX PRÉCÉDENTES)

SPECIFIC GRAVITY
(POIDS SPÉCIFIQUE) Gs

SIEVE (CRIBLAGE)	GRAIN SIZE (mm) (GRANUROMÉTRIE)	50.8	38.1	25.4	19.1	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)							100	99.9	98.2	80.8	14.6	7.4
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												

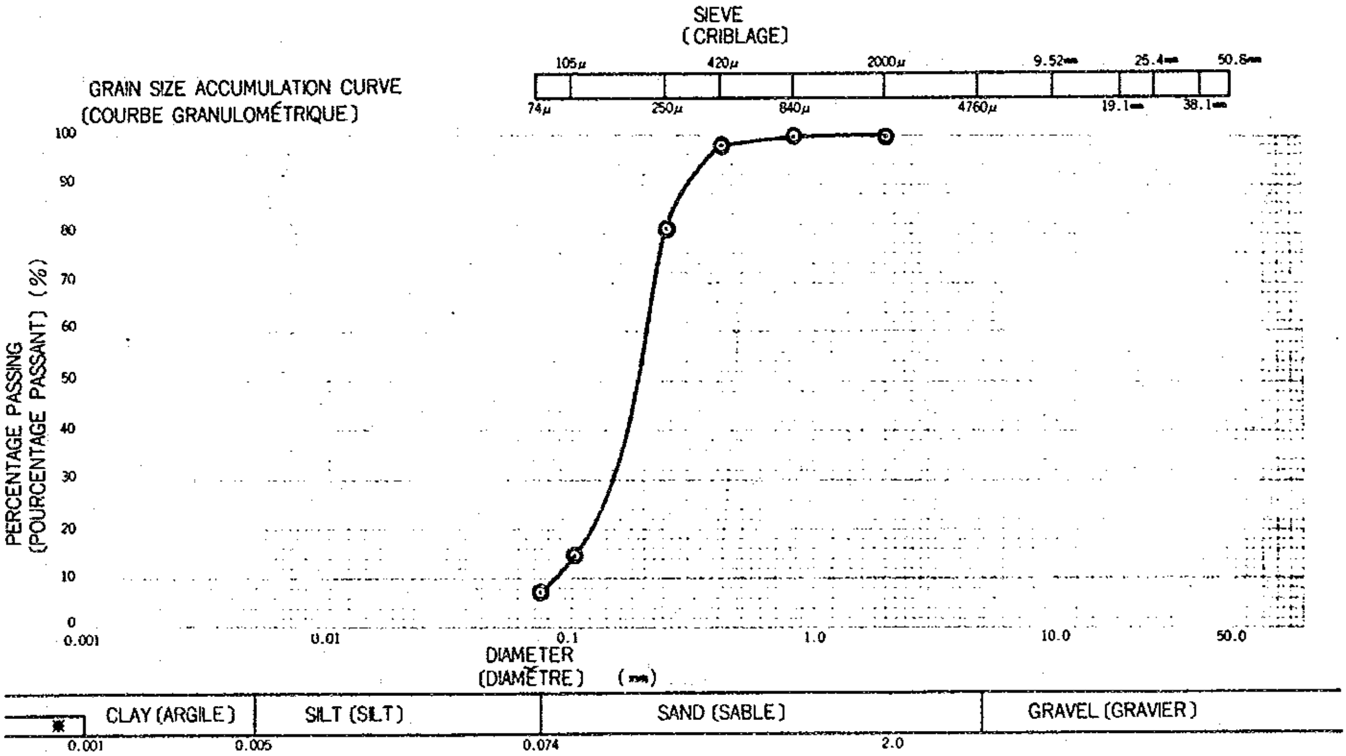


Fig. 7.18 GRADATION CURVE OF MIDDLE AGNO RIVER SAND

PROPORTION (PROPORTION)				
4.76mm <	0 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	2.0	mm
4.76 ~ 2.00mm	0 %	60% DIAMETER (DIAMÈTRE 60%)	0.20	mm
2.00 ~ 0.42mm	2 %	30% DIAMETER (DIAMÈTRE 30%)	0.15	mm
0.42 ~ 0.074mm	91 %	10% DIAMETER (DIAMÈTRE 10%)	0.085	mm
0.074 ~ 0.005mm	7 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D' UNIFORMITÉ)	2.4	
0.005mm >	— %	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	1.3	

N. K. FORM NO. 002 (1975)

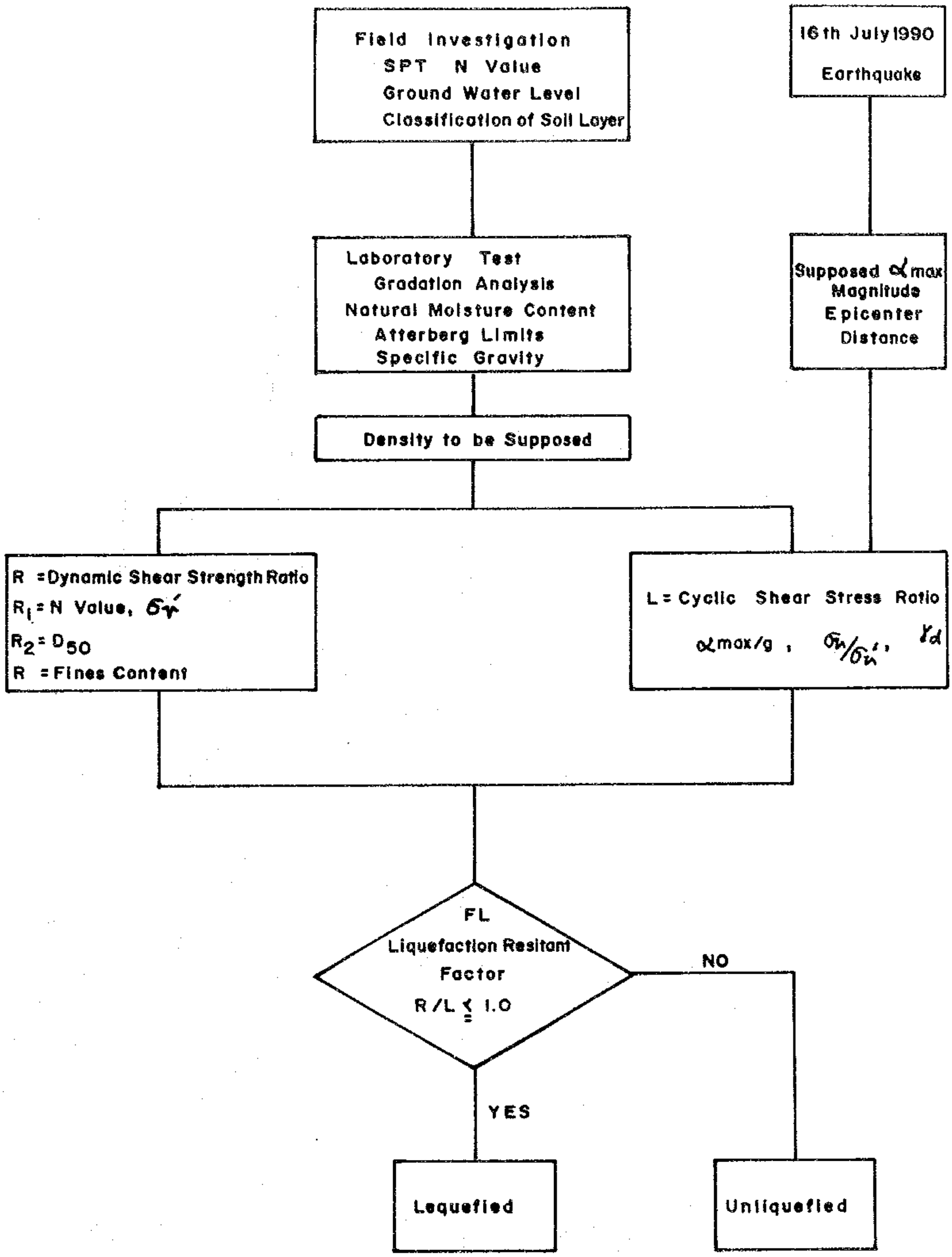


Fig. 8.1 FLOW OF LIQUEFACTION ANALYSIS

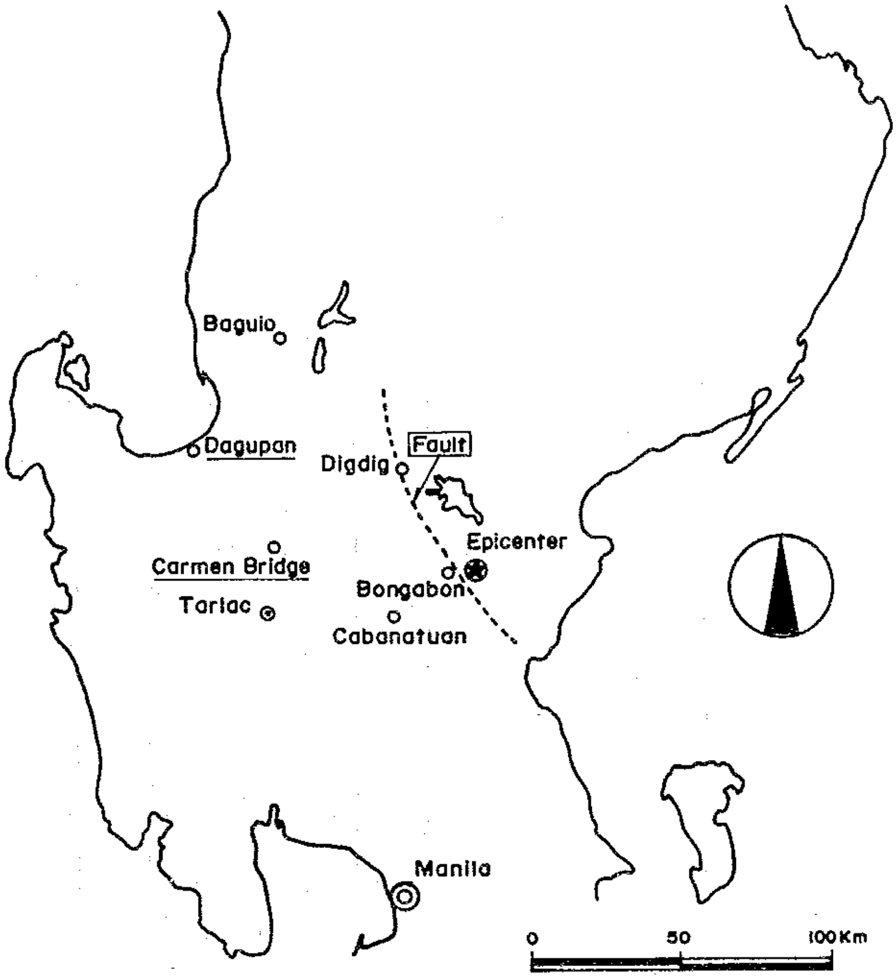
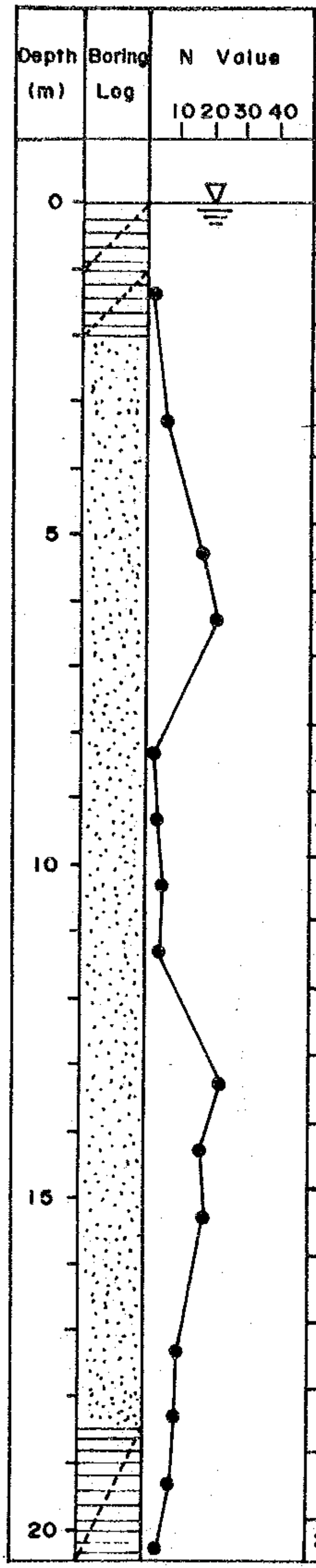


Fig. 8.2 EPICENTER AND FAULT OF 16 JULY 1990 EARTHQUAKE



Calculation Depth (m)	N Value (blow)	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D_{50} mm	ρ_{sat} (tf/m³)	FC (%)	R_1	R_2	R_3	R	Reduction Factor (γ_d)	L	F_L	Judgement
1.3	1	0.234	0.104	(0.04)	1.8	88	0.098	0.212	0.192	0.502	0.981	0.353	1.42	X
2.3						15								
3.3	6	0.614	0.284	0.14		26	0.218	0.090	0.0	0.308	0.951	0.329	0.94	O
4.3						21								
5.3	17	1.004	0.474	0.16		21	0.336	0.076	0.0	0.412	0.921	0.312	1.32	X
6.3	21	1.199	0.569	0.16			0.359	0.076	0.0	0.435	0.906	0.305	1.43	X
7.3						22								
8.3	2	1.589	0.759	0.21		12	0.103	0.050	0.0	0.153	0.876	0.293	0.52	O
9.3	3	1.784	0.854	0.21			0.123	0.050	0.0	0.173	0.861	0.288	0.60	O
10.3	5	1.979	0.949	0.24	1.95	14	0.154	0.037	0.0	0.191	0.846	0.282	0.68	O
11.3	4	2.174	1.044	0.24			0.134	0.037	0.0	0.171	0.831	0.277	0.62	O
12.3						11								
13.3	23	2.564	1.234	0.10			0.304	0.122	0.0	0.426	0.801	0.266	1.60	X
14.3	17	2.759	1.329	0.10		33	0.255	0.122	0.0	0.377	0.786	0.261	1.44	X
15.3	18	2.954	1.424	0.10			0.257	0.122	0.0	0.379	0.771	0.256	1.48	X
16.3						24								
17.3	10	3.344	1.614	0.12			0.183	0.105	0.0	0.288	0.741	0.246	1.17	X
18.3	9	3.539	1.709	0.12			0.170	0.105	0.0	0.275	0.726	0.241	1.14	X
19.3	8					84								
20.3	4													

Note: O Liquefiable Layer Ks = 0.16
X Unliquefiable Layer

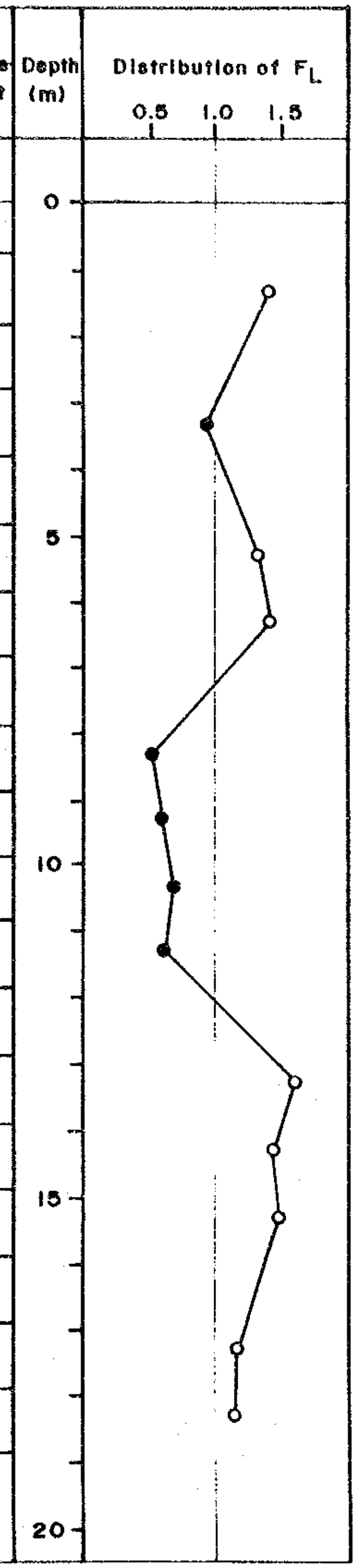
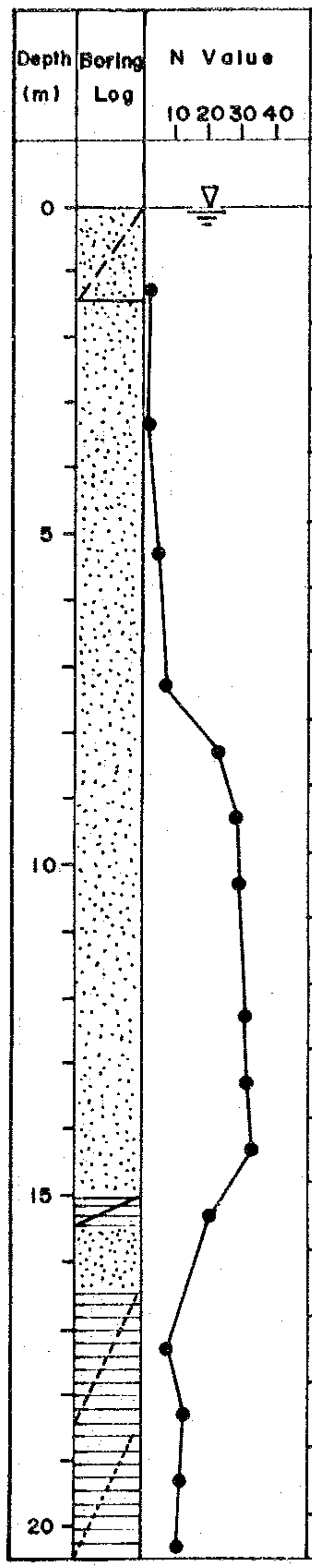


Fig. 8.3 LIQUEFACTION RESISTANT FACTOR FL OF DG-1



Calculation Depth (m)	N Value (blow)	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D_{50} (mm)	γ_{sat} (tf/m³)	FC (%)	R_1	R_2	R_3	R	Reduction Factor (γ_d)	L	F_L	Judgement
	Basic				Data		Dynamic Shear Strength Ratio							
1.3	2	0.254	0.124	0.26		19	0.137	0.029	0.0	0.166	0.981	0.321	0.52	O
2.3						16								
3.3	1	0.644	0.314	0.11		17	0.088	0.113	0.0	0.201	0.951	0.312	0.64	O
4.3						25								
5.3	5	1.034	0.504	0.16		21	0.180	0.076	0.0	0.256	0.921	0.302	0.85	O
6.3						23								
7.3	7	1.424	0.694	0.20	1.95	24	0.198	0.055	0.0	0.253	0.891	0.293	0.86	O
8.3	23	1.619	0.789	0.14		15	0.347	0.090	0.0	0.437	0.876	0.288	1.52	X
9.3	29	1.814	0.884	0.14			0.377	0.090	0.0	0.467	0.861	0.283	1.65	X
10.3	30	2.009	0.979	0.23			0.373	0.041	0.0	0.414	0.846	0.278	1.49	X
11.3						4								
12.3	31	2.399	1.169	0.23			0.359	0.041	0.0	0.400	0.816	0.268	1.49	X
13.3	32	2.594	1.264	0.20		6	0.356	0.055	0.0	0.411	0.801	0.263	1.56	X
14.3	33	2.789	1.359	0.20			0.353	0.055	0.0	0.408	0.786	0.258	1.58	X
15.3	21													
16.3						21								
17.3	8					94								
18.3	13													
19.3	12					86								
20.3	11													

Note : O Liquefiable Layer Ks = 0.16
X Unliquefiable Layer

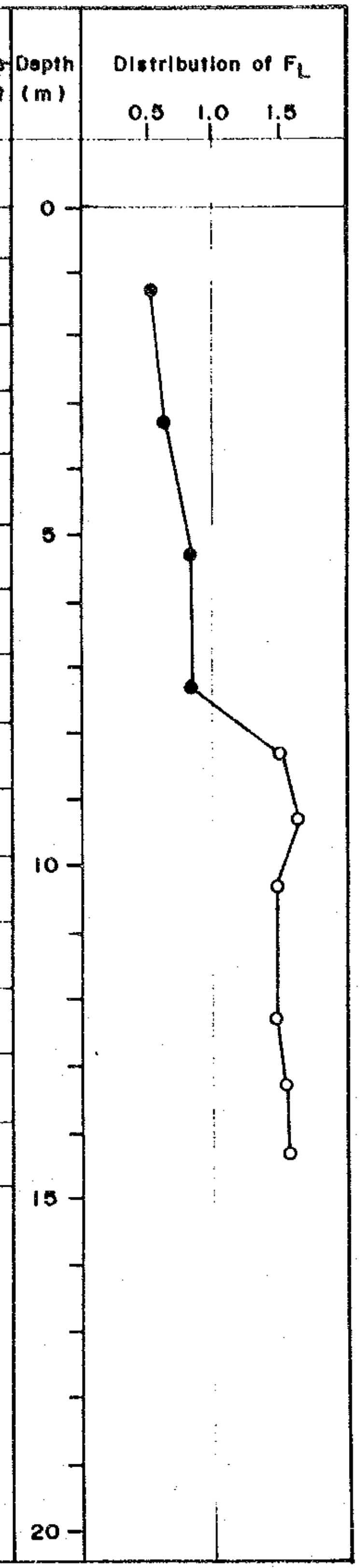
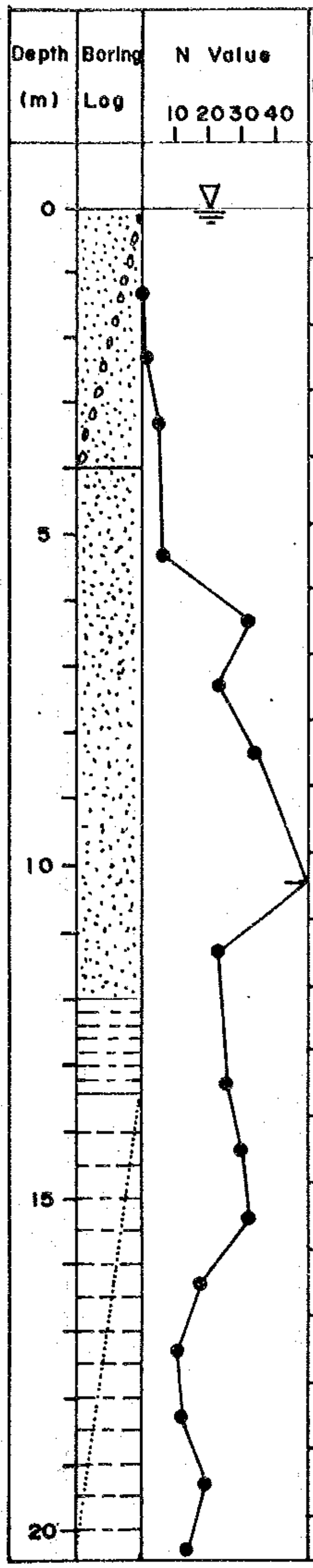


Fig. 8.4 LIQUEFACTION RESISTANT FACTOR FL OF DG-3



Calculation Depth (m)	N Value (blow)	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D_{50} (mm)	γ_{sat} (tf/m³)	FC (%)	R_1	R_2	R_3	R	Reduction Factor (γ_d)	L	F_L	Judgement
1.3	0				2.00	15								
2.3	1	0.46	0.23	0.20		23	0.091	0.055	0.0	0.146	0.966	0.309	0.47	O
3.3	5	0.66	0.33	0.20			0.194	0.055	0.0	0.249	0.951	0.304	0.82	O
4.3						15								
5.3	6	1.054	0.524	0.21		15	0.195	0.050	0.0	0.245	0.921	0.296	0.83	O
6.3	32	1.249	0.619	0.34			0.434	0.003	0.0	0.437	0.906	0.293	1.49	X
7.3	23	1.444	0.714	0.34	1.95	9	0.356	0.003	0.0	0.359	0.891	0.288	1.25	X
8.3	34	1.639	0.809	0.34			0.419	0.003	0.0	0.422	0.876	0.284	1.49	X
9.3						18								
10.3	70	2.029	0.999	0.18			0.566	0.065	0.0	0.631	0.846	0.275	2.29	X
11.3	24	2.224	1.094	0.15		18	0.323	0.082	0.0	0.405	0.831	0.270	1.50	X
12.3						80								
13.3	26													
14.3	30					85								
15.3	32													
16.3	18					70								
17.3	11													
18.3	12													
19.3	20					87								
20.3	14													

Note: O Liquefiable Layer Ks = 0.16
X Unliquefiable Layer

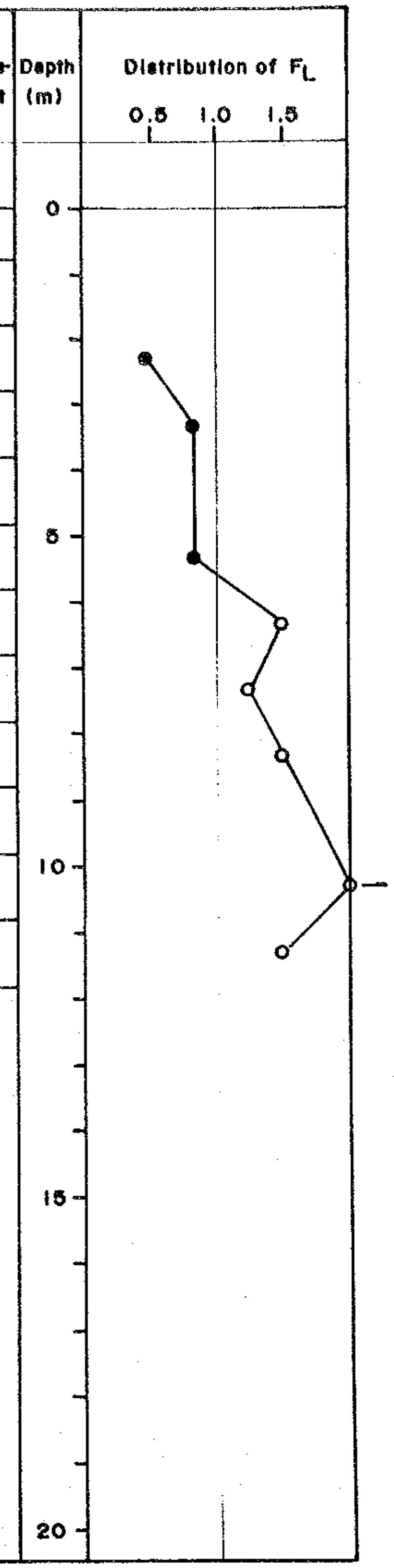
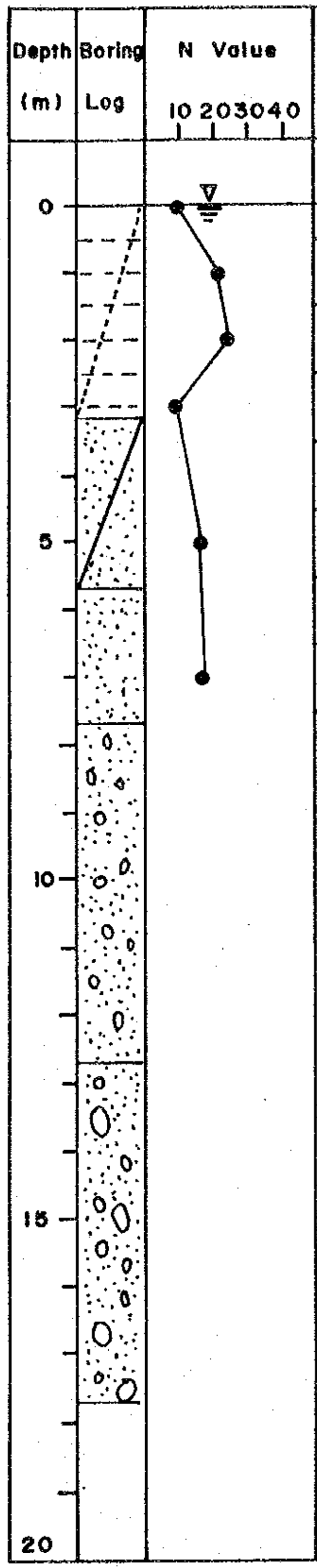


Fig. 8.5 LIQUEFACTION RESISTANT FACTOR FL OF DG-5



Calculation Depth (m)	N Value (blow)	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D_{50} (mm)	ρ_{sat} (tf/m^3)	FC (%)	R_1	R_2	R_3	R	Reduction Factor (γ_d)	L	F_L	Judgement
0	10				1·8	64								
1.0	22	0.180	0.08	0.04		70	0.468	0.212	0.120	0.800	0.985	0.501	1.60	X
2.0	25	0.360	0.16	0.04		72	0.476	0.212	0.128	0.816	0.970	0.493	1.66	X
3.0	10	0.540	0.24	0.04		87	0.288	0.212	0.188	0.688	0.955	0.486	1.42	X
4.0						28								
5.0	17	0.900	0.40	0.13		26	0.347	0.097	0.0	0.444	0.925	0.470	0.94	O
6.0					1·95	12								
7.0	18	1.280	0.58	0.19		13	0.331	0.060	0.0	0.391	0.895	0.447	0.87	O

Note: O Liquefiable Layer Ks= 0.226
X Unliquefiable Layer

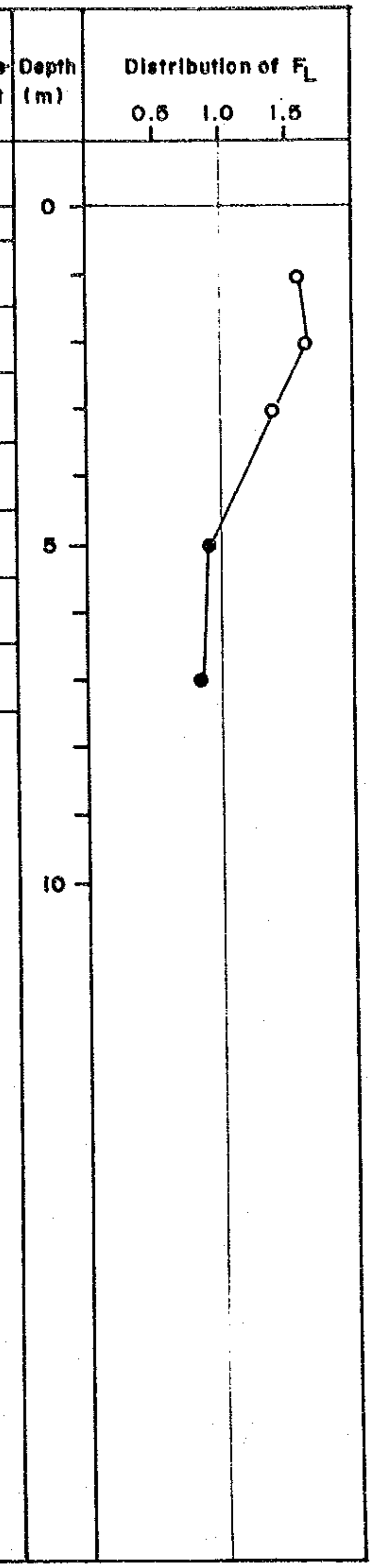
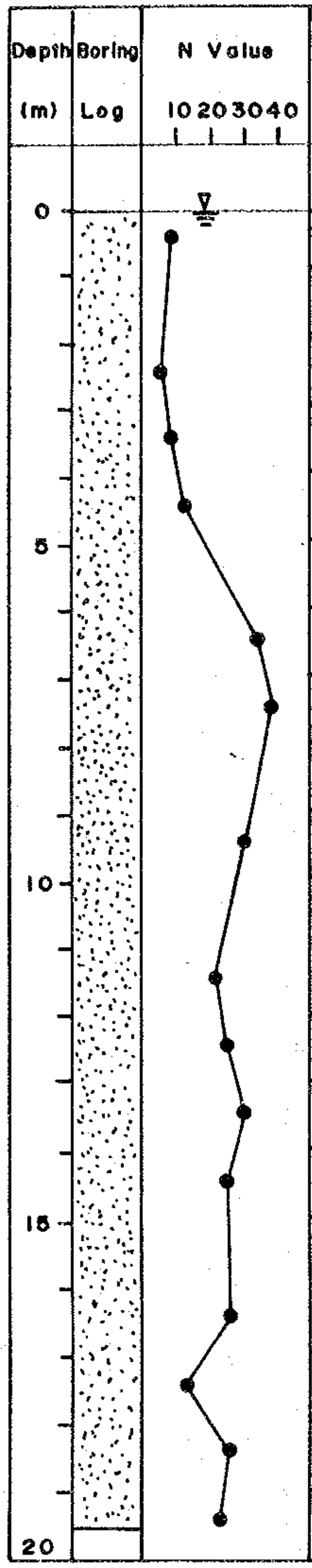
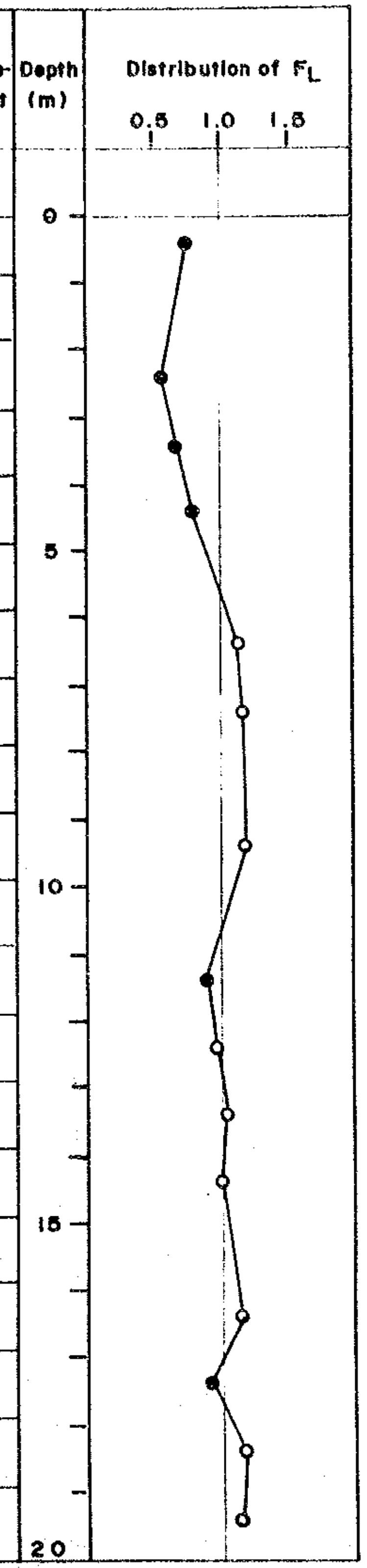


Fig. 8.6 LIQUEFACTION RESISTANT FACTOR FL OF MA-2

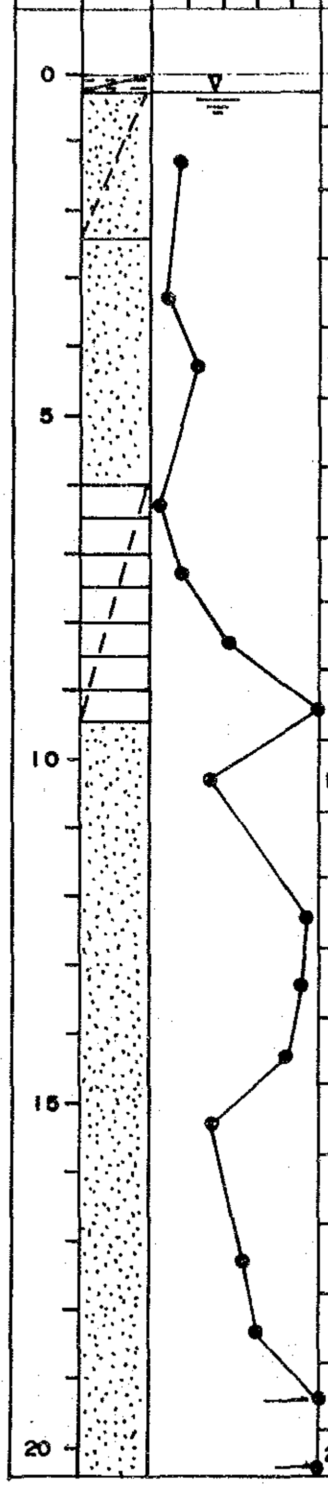


Calculation Depth (m)	Basic Data: N Value (blow)	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D_{50} (mm)	ρ_{sat} (tf/m^3)	FC (%)	Dynamic Shear Strength Ratio: R_1	R_2	R_3	R	Reduction Factor (γ_d)	L	F_L	Judgement
0.4	9	0.078	0.038	0.21			0.308	0.050	0.0	0.358	0.994	0.461	0.78	O
1.4						18								
2.4	6	0.468	0.228	0.23		21	0.224	0.041	0.0	0.265	0.964	0.447	0.59	O
3.4	9	0.663	0.323	0.23		19	0.262	0.041	0.0	0.303	0.949	0.440	0.69	O
4.4	13	0.858	0.418	0.20		13	0.301	0.055	0.0	0.356	0.934	0.433	0.82	O
5.4						16								
6.4	35	1.248	0.608	0.26			0.456	0.029	0.0	0.485	0.904	0.419	1.16	X
7.4	39	1.443	0.703	0.26			0.465	0.029	0.0	0.494	0.889	0.412	1.20	X
8.4														
9.4	31	1.833	0.893	0.16		31	0.389	0.076	0.0	0.465	0.859	0.399	1.17	X
10.4					1.95	17								
11.4	22	2.223	1.083	0.22			0.310	0.045	0.0	0.355	0.829	0.385	0.92	O
12.4	26	2.418	1.178	0.21		22	0.328	0.049	0.0	0.377	0.814	0.378	1.00	X
13.4	31	2.613	1.273	0.21			0.350	0.049	0.0	0.399	0.799	0.371	1.08	X
14.4	26	2.808	1.368	0.18		9	0.313	0.065	0.0	0.378	0.784	0.364	1.04	X
15.4						12								
16.4	27	3.198	1.558	0.11			0.305	0.113	0.0	0.418	0.754	0.350	1.19	X
17.4	14	3.393	1.653	0.11			0.215	0.113	0.0	0.328	0.739	0.343	0.96	O
18.4	27	3.588	1.748	0.11			0.293	0.113	0.0	0.406	0.724	0.336	1.21	X
19.4	24	3.783	1.843	0.11			0.271	0.113	0.0	0.384	0.709	0.329	1.17	X

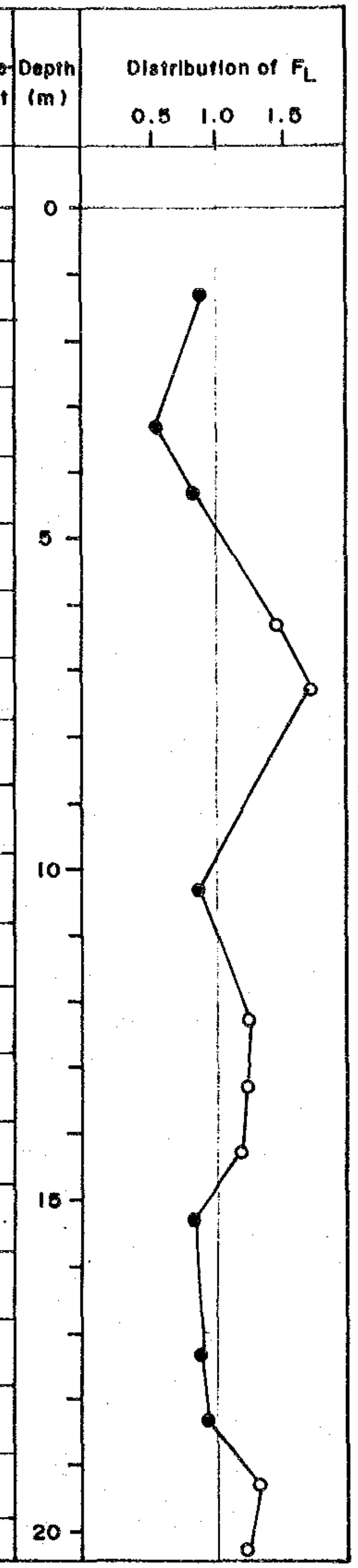


Note: O Liquefiable Layer Ks=0.226
X Unliquefiable Layer

Fig. 8.7 LIQUEFACTION RESISTANT FACTOR FL OF MA-5



Calculation Depth (m)	Basic Data: N Value (blow)	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D_{50} (mm)	ρ_{sat} (tf/m³)	FC (%)	Dynamic Shear Strength Ratio: R_1	R_2	R_3	R	Reduction Factor (r_d)	L	F_L	Judgement
					ρ_t = 1.6									
1.3	10	0.228	0.128	0.19	1.8	15	0.307	0.060	0.0	0.367	0.981	0.395	0.93	O
2.3						24								
3.3	6	0.601	0.301	0.25		11	0.216	0.033	0.0	0.249	0.951	0.429	0.58	O
4.3	15	0.796	0.396	0.21	1.95	8	0.326	0.050	0.0	0.376	0.936	0.425	0.88	O
5.3						6								
6.3	4	1.180	0.580	0.025		91	0.156	0.258	0.204	0.618	0.906	0.416	1.49	X
7.3	10	1.355	0.655	0.025	1.75	97	0.240	0.258	0.228	0.726	0.891	0.417	1.74	X
8.3	24													
9.3	50													
10.3	19	1.897	0.897	0.18		18	0.304	0.065	0.0	0.369	0.846	0.404	0.91	O
11.3						17								
12.3	47	2.287	1.087	0.21			0.452	0.050	0.0	0.502	0.816	0.388	1.29	X
13.3	45	2.482	1.182	0.21			0.431	0.050	0.0	0.481	0.801	0.380	1.27	X
14.3	41	2.677	1.277	0.21			0.402	0.050	0.0	0.452	0.786	0.372	1.22	X
15.3	19	2.872	1.372	0.21	1.95		0.267	0.050	0.0	0.317	0.771	0.365	0.87	O
16.3						11								
17.3	28	3.262	1.562	0.31			0.310	0.012	0.0	0.322	0.741	0.350	0.92	O
18.3	32	3.457	1.657	0.31			0.325	0.012	0.0	0.337	0.726	0.342	0.99	O
19.3	61	3.652	1.752	0.31			0.440	0.012	0.0	0.452	0.711	0.335	1.35	X
20.3	53	3.847	1.847	0.31			0.402	0.012	0.0	0.414	0.696	0.328	1.26	X



Note : O Liquefiable Layer Ks=0.226
X Unliquefiable Layer

Fig. 8.8 LIQUEFACTION RESISTANT FACTOR FL OF MA-6

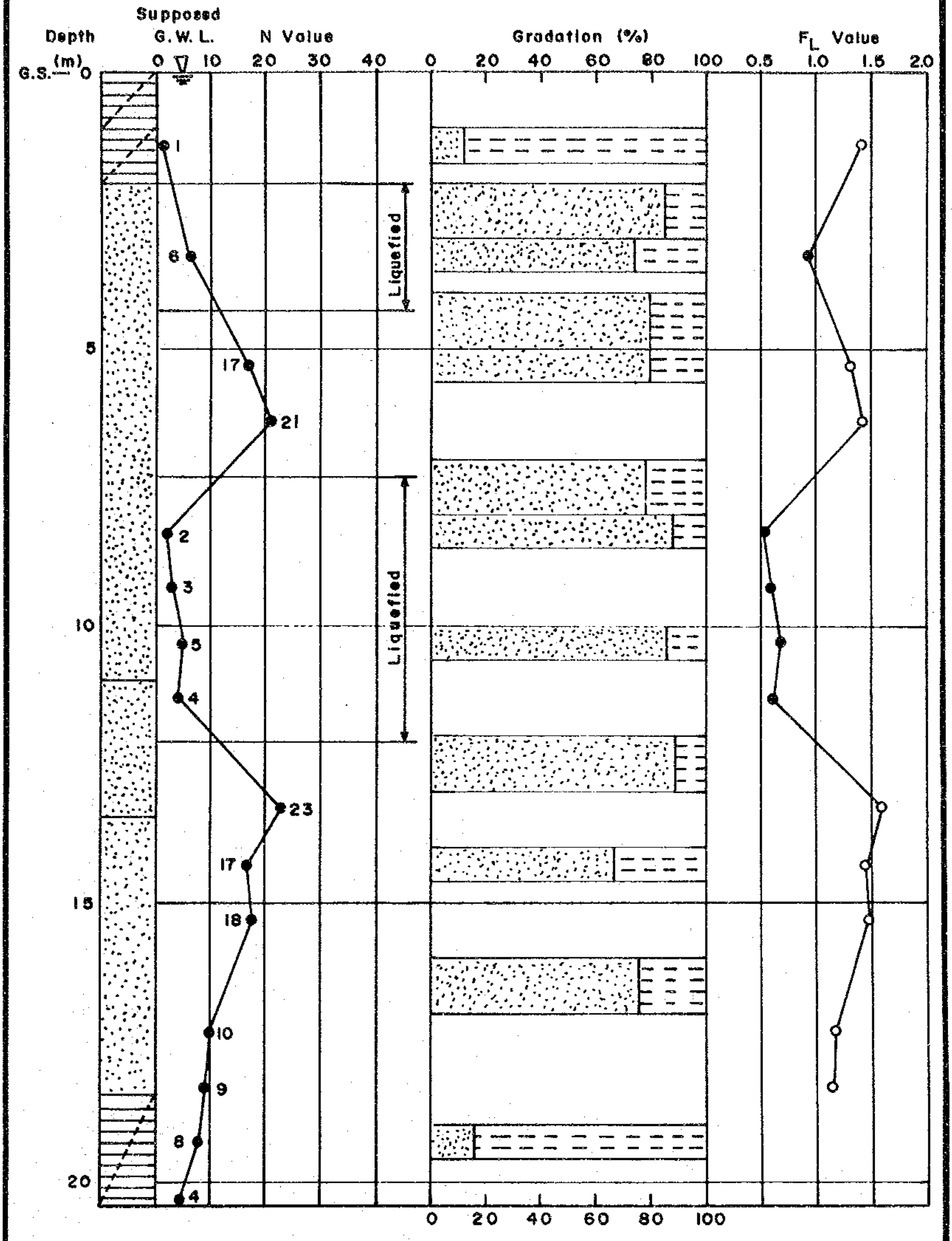


Fig. 8.9 LIQUEFIED LAYER OF DG 1

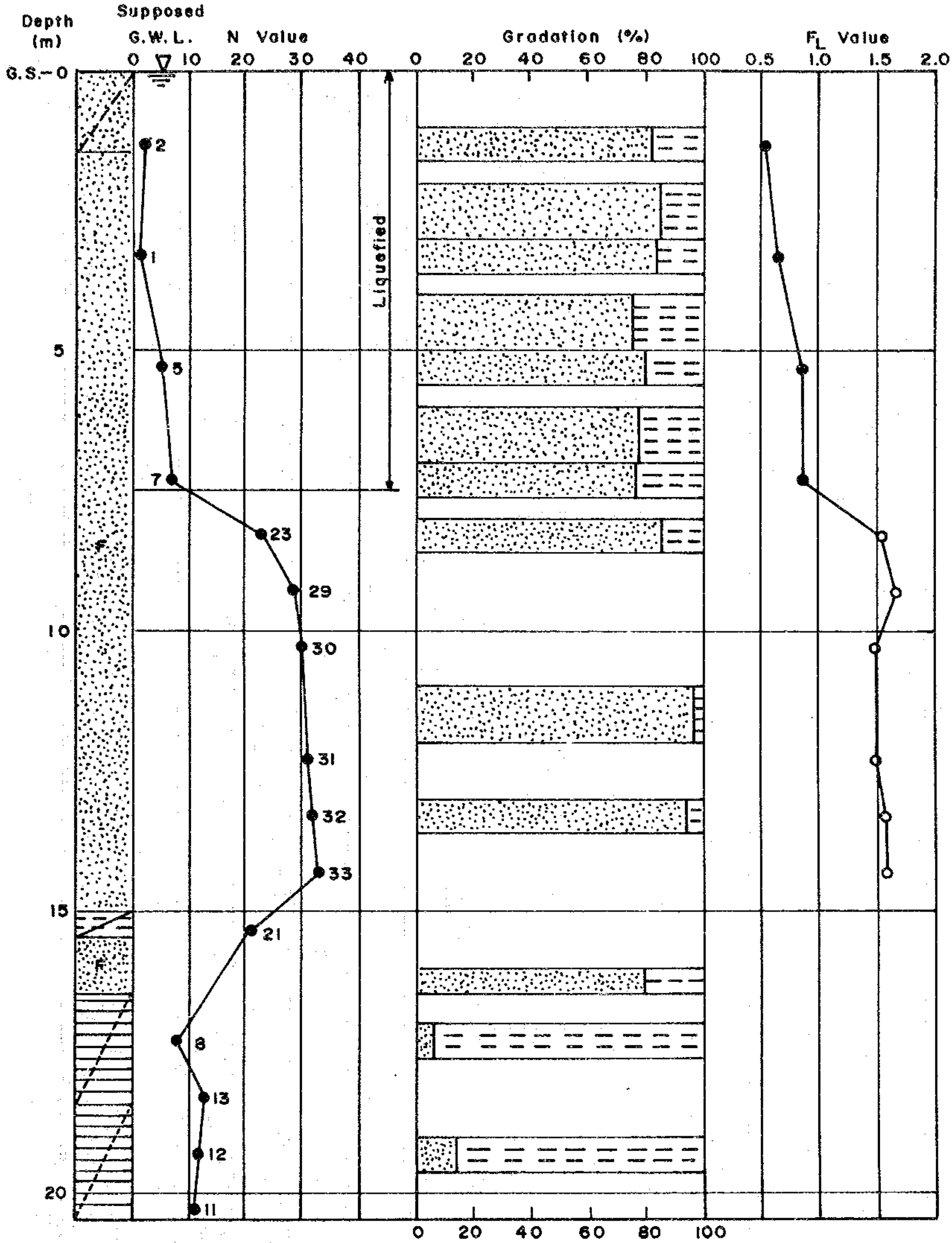


Fig.8.10 LIQUEFIED LAYER OF DG-3

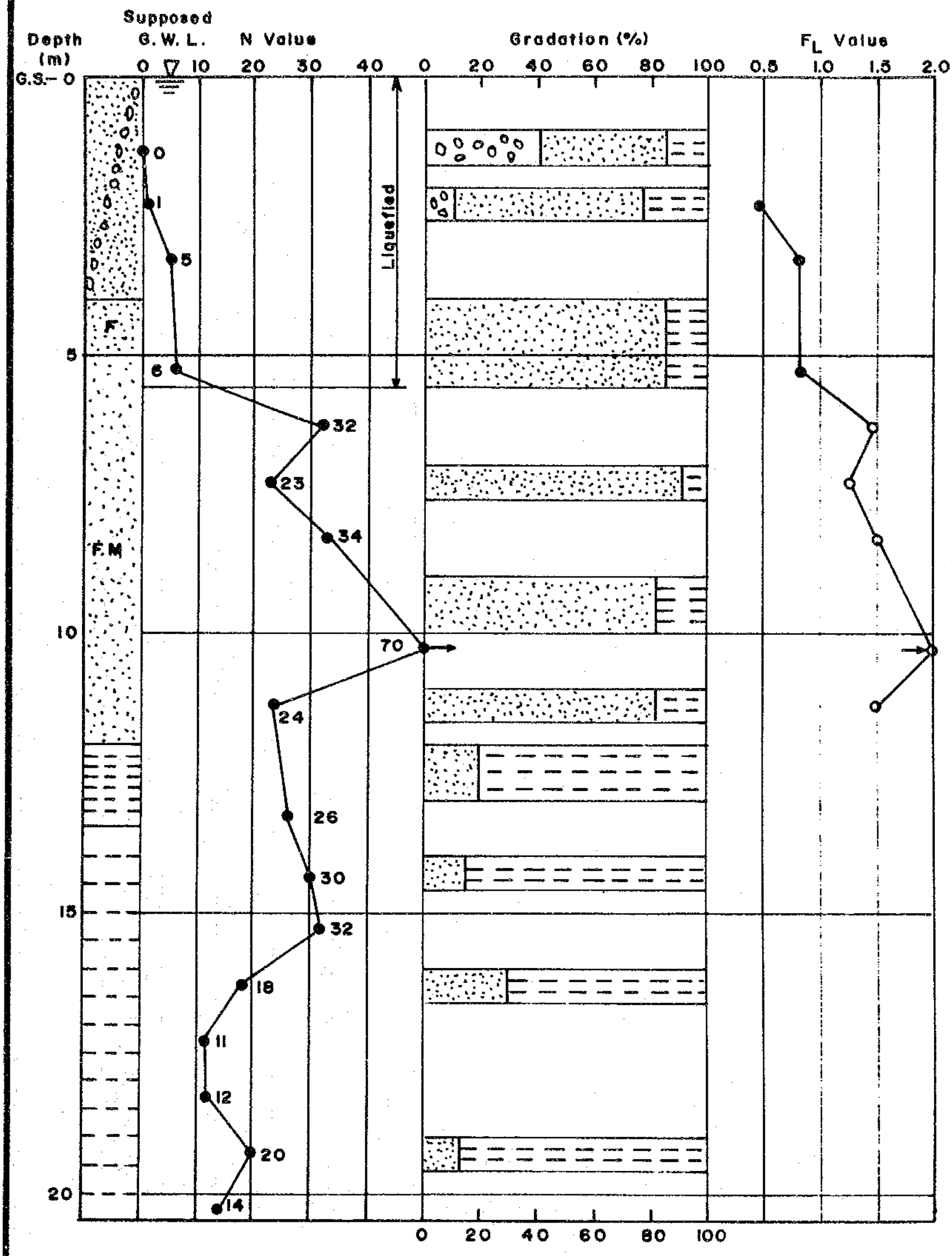


Fig.8.11 LIQUEFIED LAYER OF DG-5

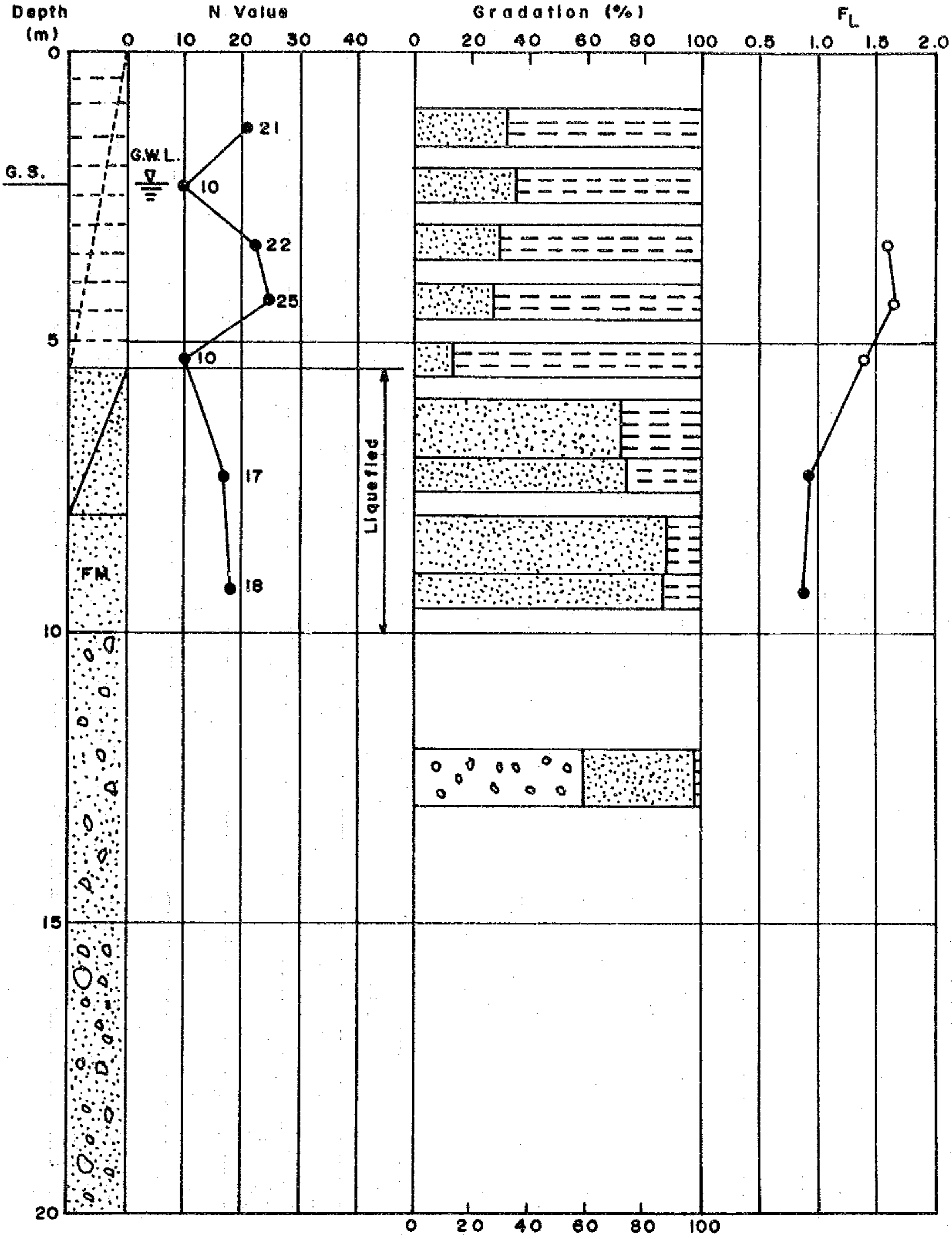


Fig.8.12 LIQUEFIED LAYER OF MA-2

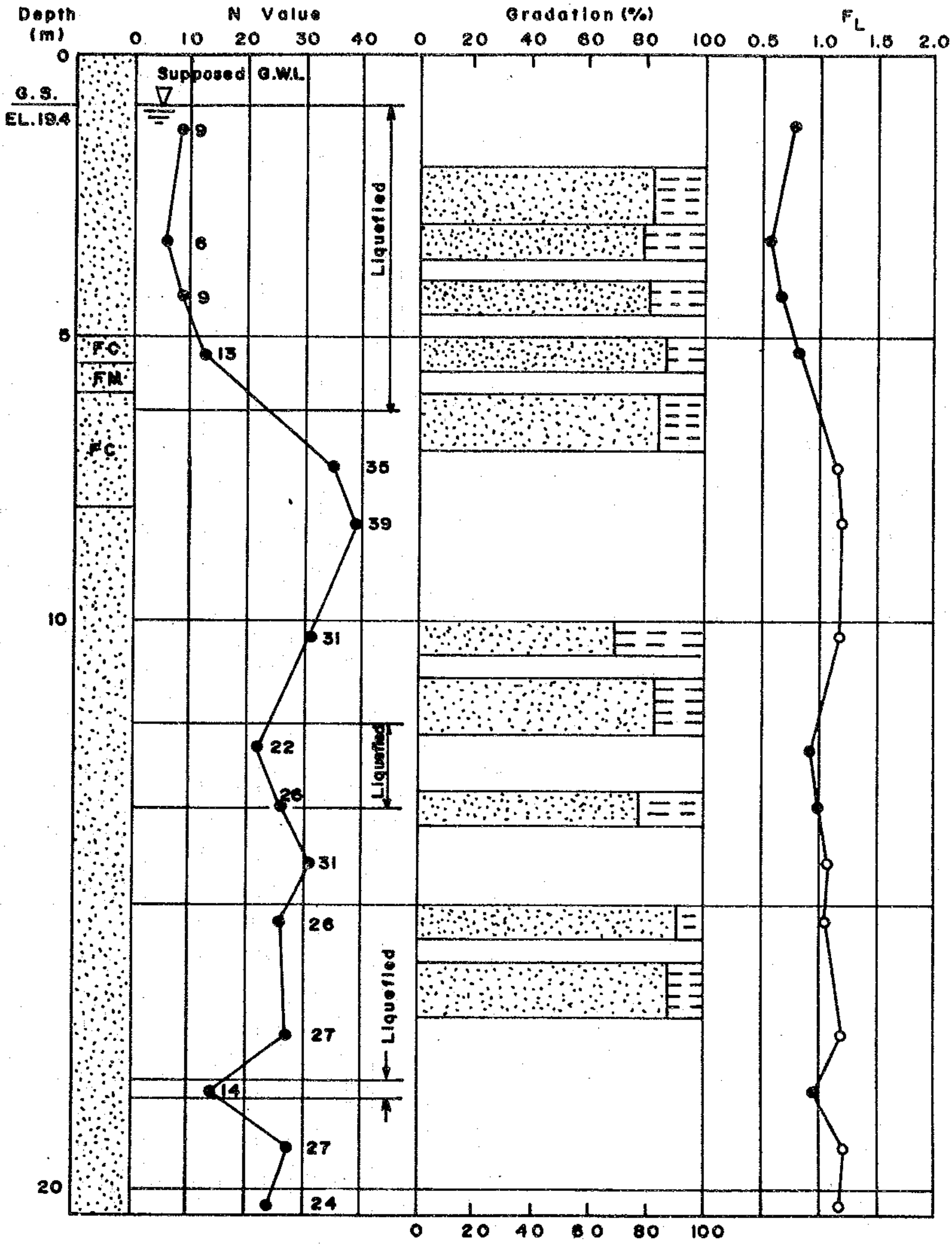


Fig.8.13 LIQUEFIED LAYER OF MA-5

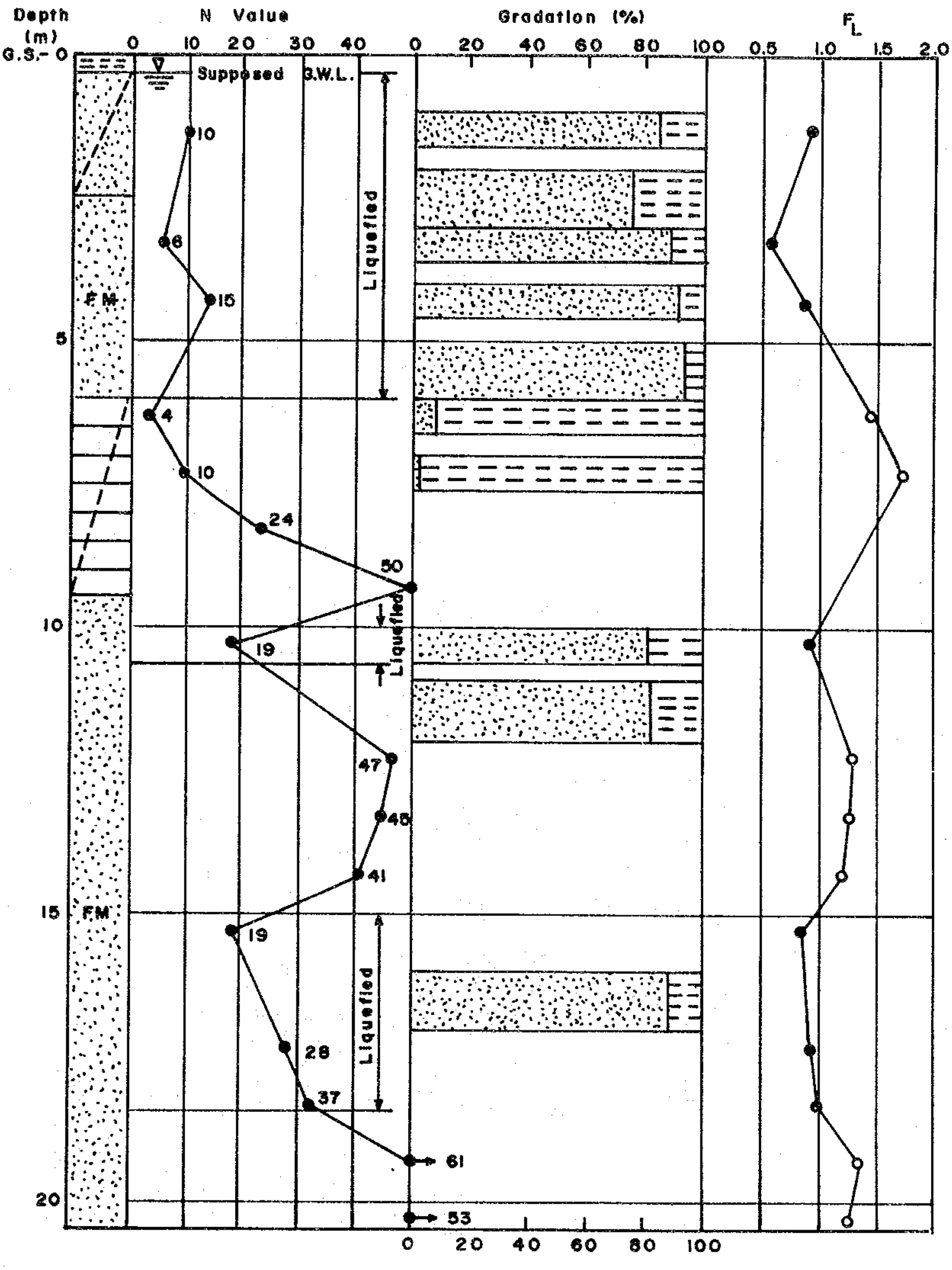
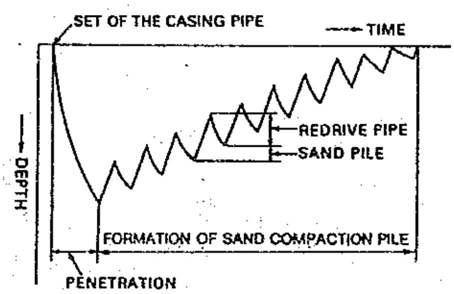


Fig.8.14 LIQUEFIED LAYER OF MA-6

Process

(1) Set the pipe at the specified position on the ground.
(2) Actuate the vibrator to penetrate the pipe into the ground. When there is a hard layer which makes it difficult to penetrate the pipe, water or air jet is used to force penetration.
(3) Penetration reaches a design depth.
(4) A quantity of sand is placed in the pipe from the upper hopper and while drawing up the pipe to the specified level, sand in the pipe is discharged into the bored hole by compressed air.
(5) The pipe is redriven into the hole and sand is compacted by vibration. Sand is compressed into the surrounding subsoil layer.
(6) Again feed sand into the pipe and draw up the pipe to the specified height.
(7) By repeating the above process, complete the compozer pile up to the ground level.



DEPTH OSCILLOGRAPH

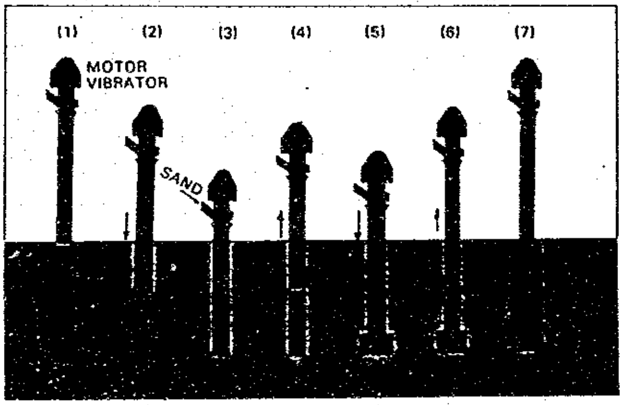
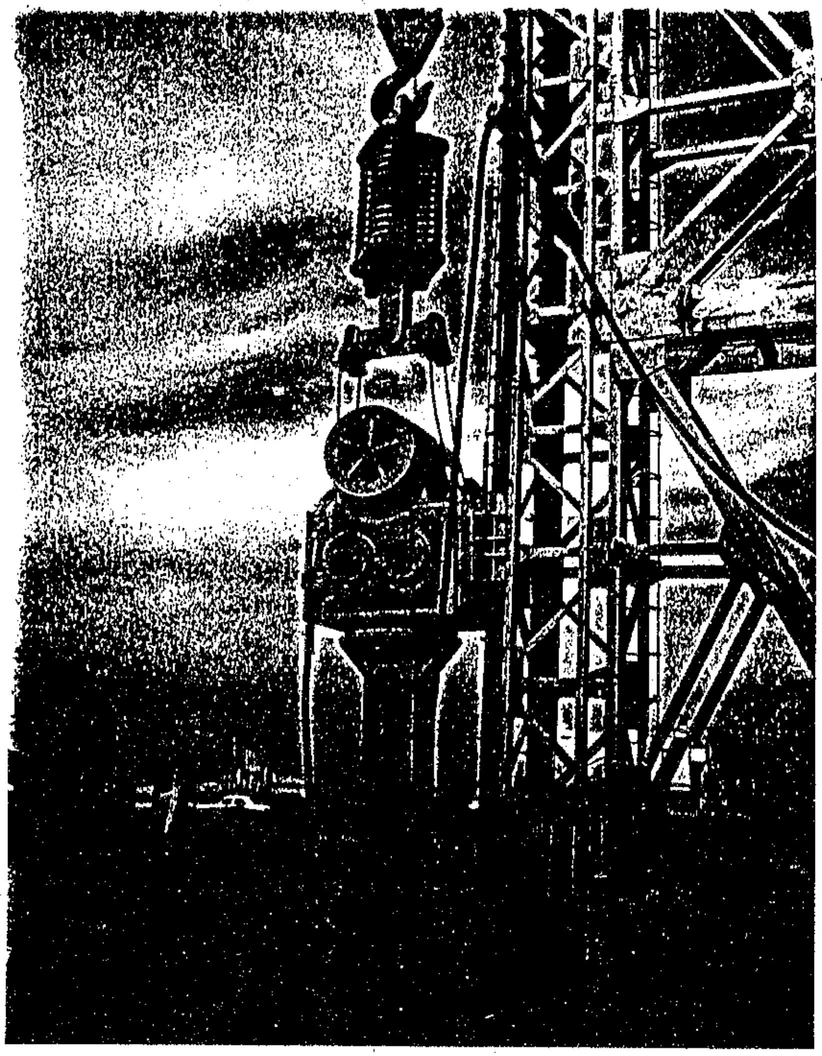


Fig. 9.1 SAND COMPACTION PILE METHOD



Vibro Rod Method

This is a method of compacting loose sandy soil by pressing under vibration, various types of special rods with characteristic projections provided at their ends and sides.

Advantages

1) Vibration compaction effect is enhanced by special rod processing.
2) Compaction force is transmitted to adjacent ground, owing to special rod processing; as interval between positions to be treated can be widened, work is economical.
3) Working machinery is light and easy to move; work efficiency becomes higher and cost can be lowered.

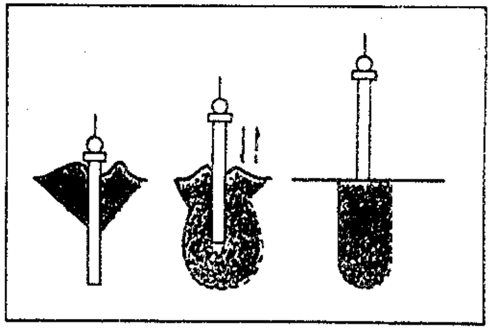


Fig. 9.2 ROD COMPACTION METHOD

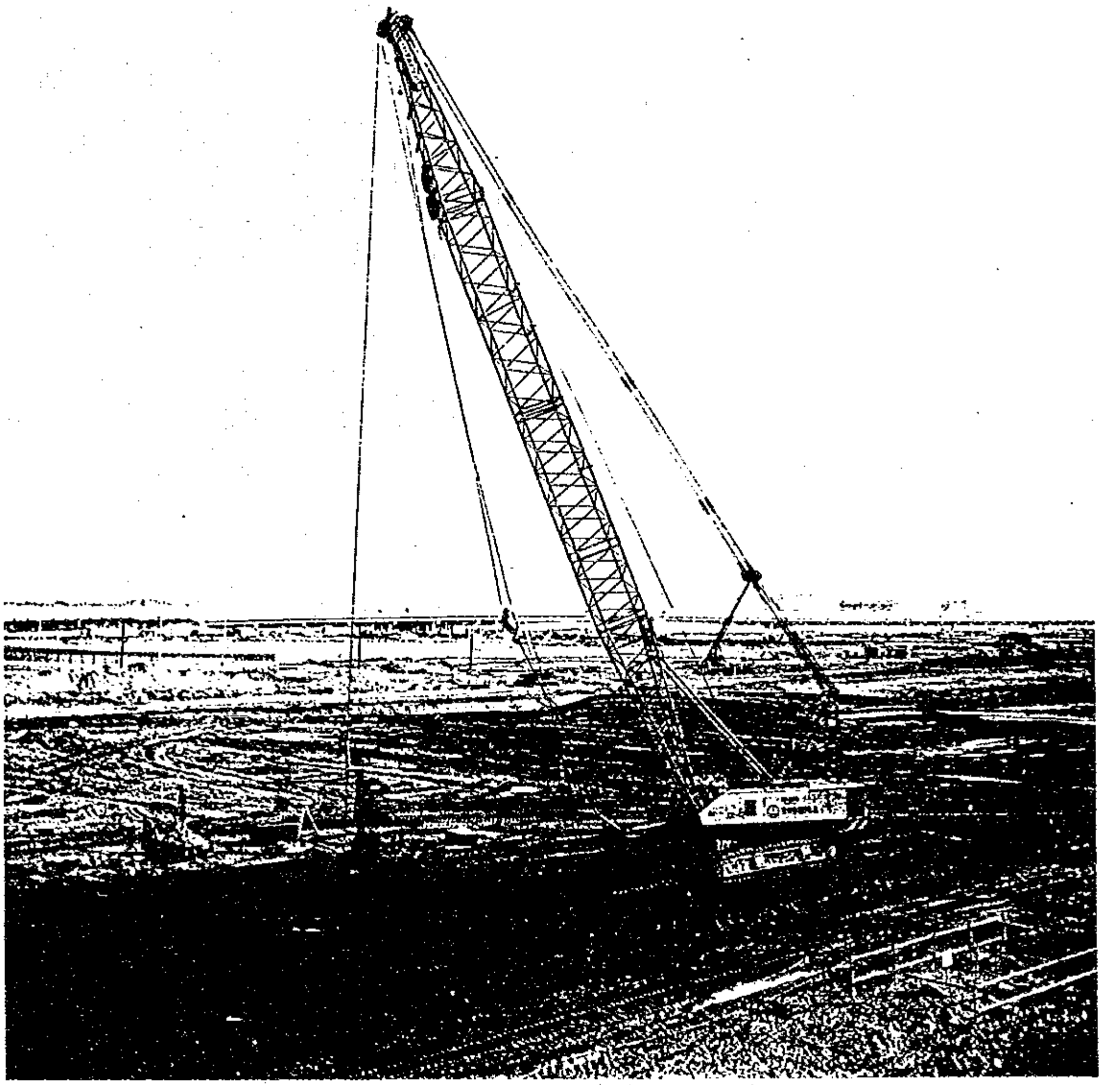
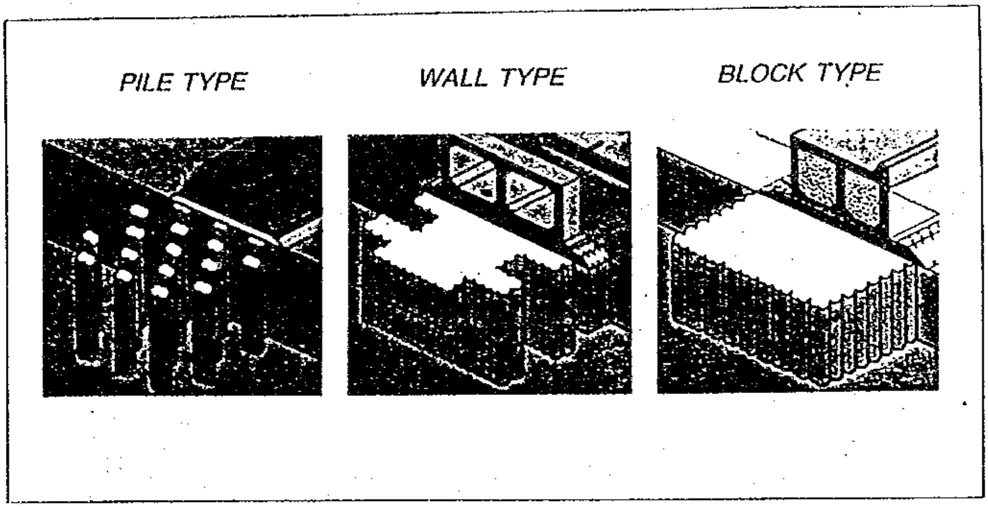


Fig. 9.3 DYNAMIC CONSOLIDATION METHOD

Improvement Type



Construction System

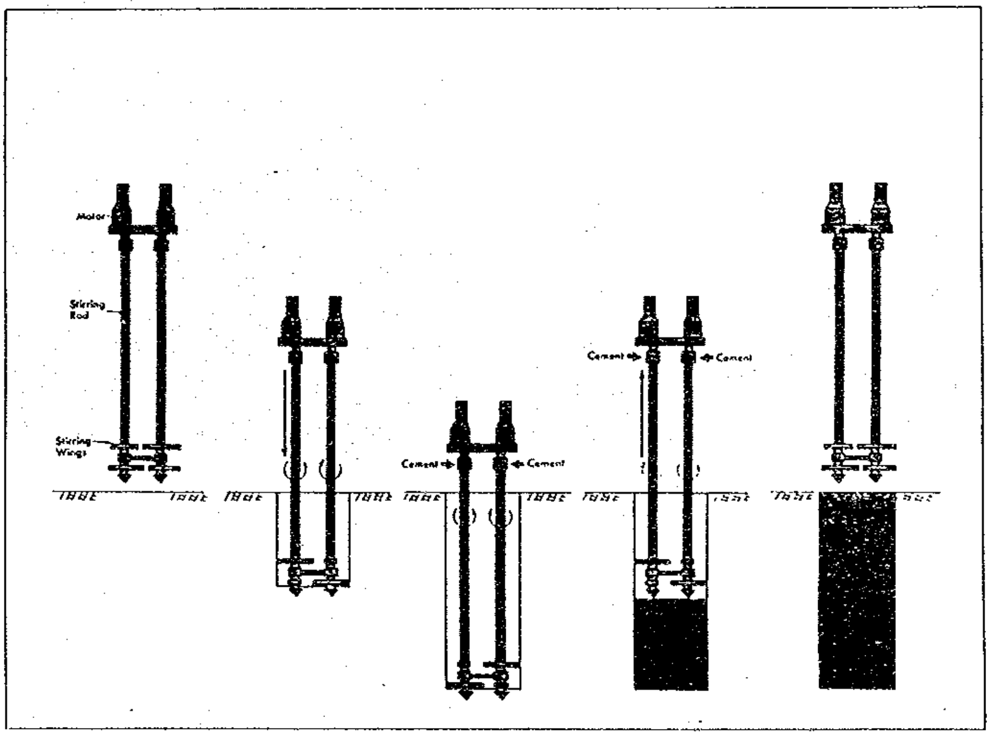


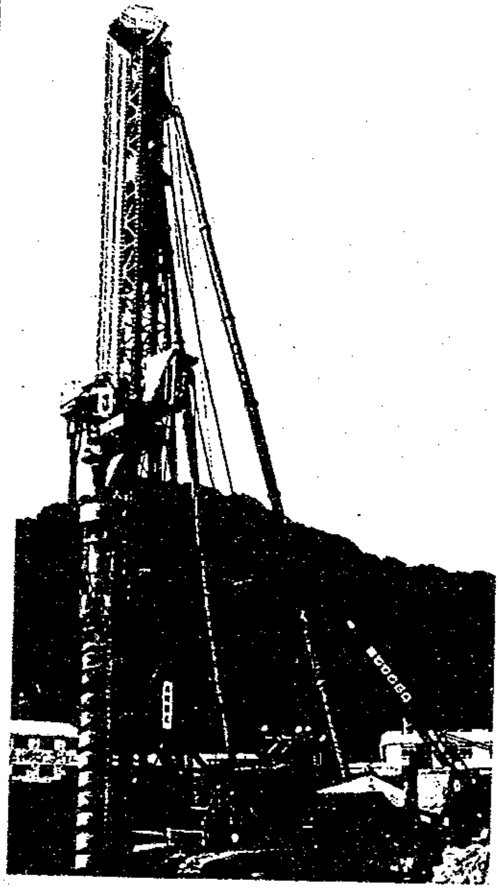
Fig. 9.4 DEEP MIXING METHOD

Gravel Drain Method

This is a different type of method in principle from the conventional compaction method, and involves forming gravel drain piles in loose sandy ground in order to prevent liquefaction of sand during earthquakes. This is effected by immeadiate dissipation of the excess pore water pressure.

Advantrages

1) Construction can be carried out without adverse effect on the adjacent ground.
2) There is no vibration effect on exisiting structures and vicinity.
3) Accordingly construction can be achieved in urban area.



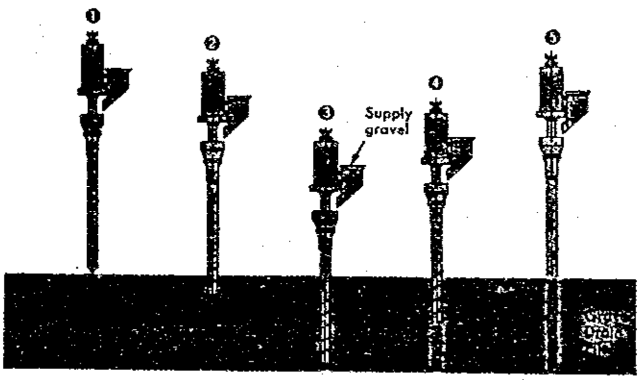


Fig. 9.5 GRAVEL PILE METHOD

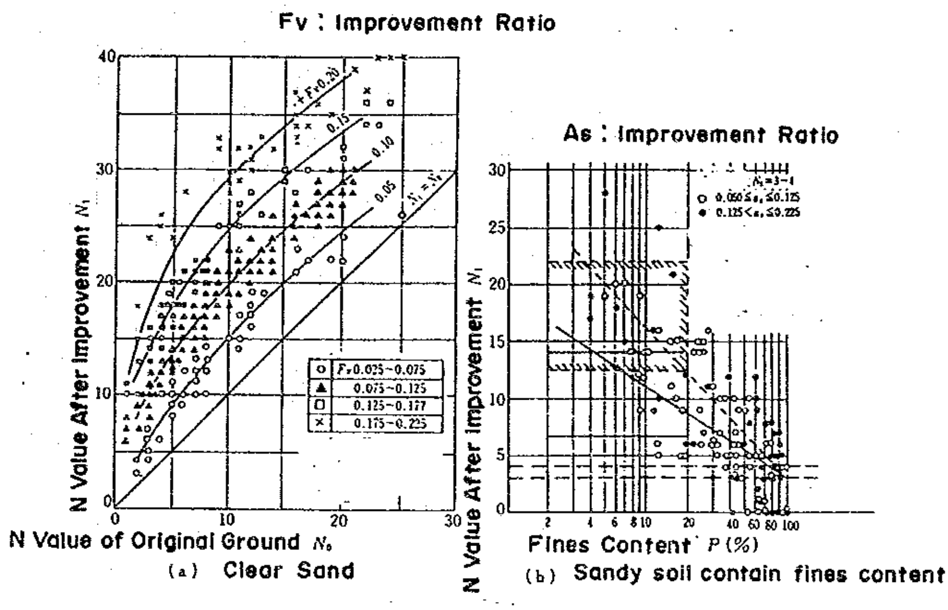


Fig. 9.6 DESIGN CHART OF SCP FOR SANDY SOILS