(II)

SOIL AND MATERIAL SURVEY

II. SOIL AND MATERIALS SURVEY

2.1 Soil Sampling and Laboratory Test

2.1.1 Main Purpose of Laboratory Test

Main purpose of the laboratory test is to analyze the soil charactor of the available embankment materials along the road.

The analysis of the embankment materials was made in view of the importance for selecting new pavement structure which will be dtermined by the strength of subgrade on the newly constructed embankment portions rather than by the newly scraped roadbeds.

Therefore the simplified CBR test was conducted on the natural moisture soil samples which were compacted with 65 blows, soaked for four days, and penetrated, according to the JIS A1211 to judge the strength of embankment materials under the worst condition considered as the heavy rainy season.

2.1.2 Method of Investigation and Sampling

The method of the investigation and sampling to be applied was selected from the past experience of the Consultant in due consideration of the present study stage of this Project and the expected schedule that the detailed survey is to be made in the next design stage.

Under this concept, the soil samples were directly digged by shovels instead of the standard method using auger required by AASHTO. This method enabled us to collect enough soil samples (amounting to around 5 tons) with visual observation as conducted by the test pit method within a limited period.

In the detailed design stage sampling will be conducted by using auger along the definite road alignment, the test results of which are to be compared with the results of the present test.

2.1.3 Location of Soil Sampling

After the visual classification of soils along the road, selection of the sampling point was made to get the comprehensive understanding of the whole road section.

The location of the soil sampling was determined in such a manner that soils to be taken are representative in the sampling zone and approximately the same intervals were kept for the sample zone.

The location of sampling points are shown in DWG-II-1.

2.1.4 Description of Soil Samples

Description of samples obtained on the existing road sides is given in Table II-1.

2.1.5 Items of Laboratory Test

The following tests were conducted on the collected samples.

Gradation test	(28 samples),
Consistency test	(27 samples),
Natural state test	(31 samples),
Compaction test	(3 samples),
CBR test	(16 samples).

2.2 Analysis of Soil Laboratory Test Results

The results of soil laboratory test are shown in Table II-2. The analysis from the test results is briefly described hereunder.

2.2.1 Evaluation of the Soil as Subgrade Material

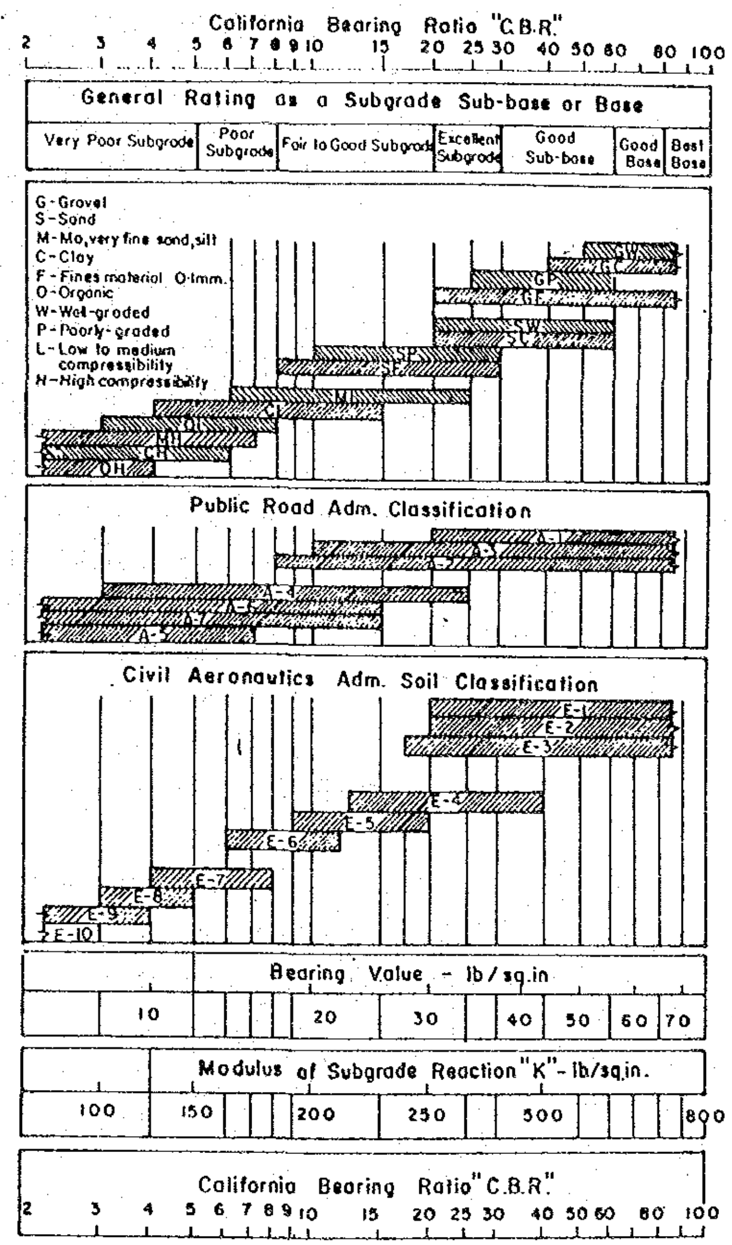
Soil classification of each sample was made by AASHTO M145-73. According to the AASHTO, M 57-64 Soil Evaluation for Subgrade, good or fair soils for subgrade are A-1, A-3 A-2-4, and A-2-5. Most of the samples carried from the site except G-2, Z-7 and V-9 are proved to be poor material for subgrade.

However, according to the Table II-3 Extended Unified Soil Classification System to Laterite Soils, most of the samples are classified into GM and GC which are identified to be good materials not only for subgrade but also for subbase.

Judging from the above two contradictory conclusions the soil character of the existing lateritic material is considered to be poor or fair for subgrade material during rainy season taking into account the soaked CBR values (4-11) which are shown in Table II-2. (see Fig. II-1)

In relation to the above analysis, the results of compaction tests were also checked. The optimum moisture contents (omc) are found out to be lower than that of natural moisture contents (Wn), because these tests were carried out during the rainy season. Therefore, if the earthworks for road improvement are carried out in dry season, it is expected that the field performance of subgrade will be completed with the good condition of the soil material.

Fig. II-1 CBR and Soil Classification



Source: Laterite Soil Engineering by M.D. Gidigasu

2.2.2 Comparison with "Problem" Laterite Soils

The general conditions of "Problem" laterite/1 soils are as follows.

A. Weathered soils formed in regious of recent volcanic activity,

B. Continuous wet climate with an average annual rainfall generally above 1500 mm,

C. Low natural densities between 0.320 g/cm^3 and 1.121 g/cm^3,

D. Friable and/or crumble structures.

Though the Project area have heavy rainfall more than 1500 mm, most of the natural densities of the soil even in the rainy season are higher values than the above 1.121 g/cm^3. In the Project area, there is no volcanic activity and no friable and crumble material.

Considering this situation, it is judged that the laterite soil in the Project area does not belong to the soil group of "Problem" laterite soil.

2.2.3 Results of Soil Laboratory Tests

The summary of soil laboratory test are shown in Table II-1, and other results of test are shown hereinafter as Test Result (1) - (9).

/1 Identified and classified as "Problem" laterite soil in *Laterite Soil Engineering*, M.D. Gidigasu, 1976.

2.3 Field Road Surface Test

2.3.1 Purpose of the Field Road Test

The field road surface tests such as field CBR test, deflection test by Benkelman beam and support layer thickness test by sounding equipment were carried out to get the supplemental data for understanding the existing laterite pavement.

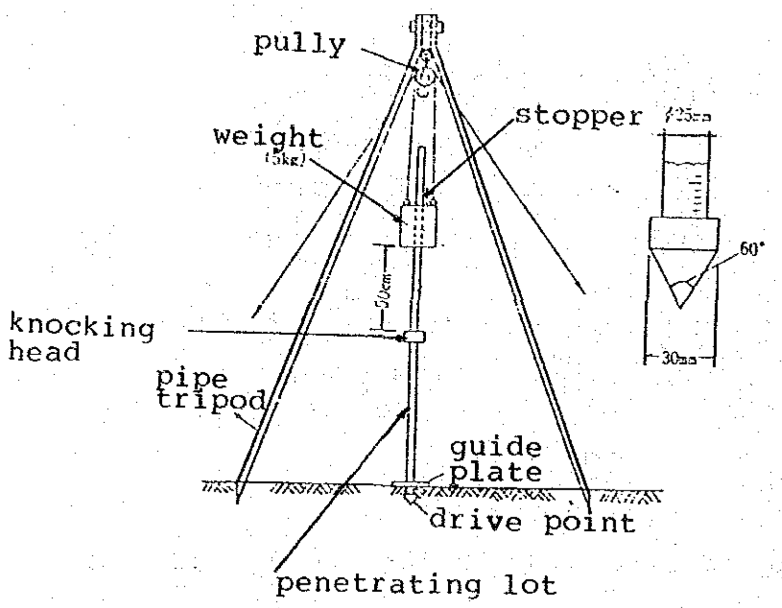
2.3.2 Method of the Road Surface Test

The field CBR tests were done on the surface of the carriageway of laterite pavement by a common field CBR test equipment which was installed on a TOYOTA 6-ton truck and the natural moisture contents of the tested surface soils were also analyzed at MPW laboratory. The graph showing the correlation between penetration depth (mm) and load (kg) was drawn and the slope of the graph was modified in linear line. The corrected load value at 2.5 mm penetration was selected and compared with the standard load.

The deflection tests were conducted by using Benkelman beam and a truck which was loaded with soil in full. Initial dial reading was recorded at the maximum deflection point, and the final dial reading was recorded after the truck load had passed. The defference of the above two values was recorded as the total rebound deflection. The two times records of these reading values show the actual deflection.

The support layer thickness test was done by the special sounding equipment/1 which was developed by the Road Research Institute of the Ministry of Construction, Japan. The dimention of the equipment is as follows:

/1 : This equipment is simple and handy compared with the core boring test equipment to judge the subsurface condition, however, there is no definite relation with other internationally authorized tests.



The test was carried out on the surface of carriageway and shoulder. The times of dropped hummer and their sunk depth were recorded and drawn. The reliable support layer thickness judged from this graph is around 20 cm.

2.3.3 Result of Road Surface Test

Summary of the field road surface test is shown in Table II-4. Some of the detailed test results of road surface tests are attached hereinafter as Test Result (10 - (12).

2.4 Borrow Pit and Quarry Site

2.4.1 Borrow Pit for Gravelly Laterite

Bowwow pit for selected laterite was investigated along the existing road. The results of the investigation are summerized below.

Gbarnga-St. Paul River: Good selected laterite was found in many portions within 5 km along the road.

St. Paul River-Zozor: The material found in this section was of poor condition along the road.

Zorzor Town Area: Good material was found only in the limited 5 km area around Zorzor town.

Konia-Lofa River: The material along the road was found to be poor condition.

Lofa-Voinjama: Only on some portion along the road, material found was of poor condition.

Voinjama-Kolahun: The material was poor along the road but rich along feeder road within 5 km from the junction to the main road.

Kolahun-Mendikoma: The condition of material was the almost same as that of Voinjama-Kolahun section, and good laterite was found near by Mendikoma but is does not include coarse aggregate.

The distribution of the gravelly laterite is shown in DWG-II-2.

2.4.2 Description of Quarry Site

Location and the reserve volume for the 10 proposed quarry sites are explained hereunder.

Site A, B & C - Belefuanai

These sites situated at Belefuanai Village on the right side of the existing road from Gbarnga with approximate distance of 1 km.

Site A is the largest in deposit,and B and C are about the same size. No over-burden problem, but with grass on the top.

Eestimated reserve in Site A: 400 meters in length, 150 meters in breast, and 80 meters in height. Volume = 400 x 150 x 80 = 4,800,000 m^3.

Estimated reserve in Sites B and C: 180 meters length, 80 meters breast, and 60 meters height. Volume = 180 x 80 x 60 = 864,000 m^3.

Site D - Gbanway

This site situates at Gbanway on both sides of the road. The deposit contains average over-burden, and should be considered as a spear side.

Estimated volume: 450 m length, 150 m breast and 80 m height. Volume = 450 x 150 x 80 = 5,400,000 m^3.

Site E - Zorzor

This site situates at 1.5 km from Zorzor after LPMC cocoa nursery garden on the left side of the existing road. It has a little over-burden, and is very economical site in terms of transportation for both sides.

Estimated deposit: 1.0 km in length, 500 m in breast and 200 m in height. Volume = 1,000 x 200 x 500 = 1×10^8 m^3.

Site F - Tennabu

This site is located on the left side of the road from Zorzor with a distance of about 500 m from road side. This site is very suitable and economical because of no overburden, exposed homogeneous deposit.

Estimated quantity: 2 km length, 500 m breast and 100 m height. Volume = 2000 x 500 x 100 = 1×10^8 m^3.

Site G - Voinjama

This site is located on the left side of Zorzor, and reached through the 1.0 km long one lane access road from the Project, about 7.0 km to Voinjama.

There are two quarry-mountains. A portable crushing plant had been operated, and provided the crushed aggregates for Voinjama town until 1978.

Estimated reserve: each length is 300 m, each breast is 100 m and height is 30 m. Volume = 2 x 300 x 100 x 30 = 1.8×10^6 m^3.

Site H - Johnny Town

This site situates at Johnny Town on about 20 m right side of the road from Voinjama. This deposite also has no over-burden and homogeneous rock exposed. It can satisfy the economical supply located half way between sites G and I.

Estimated quantity: 1.5 km length, 500 m breast and 100 m height. Volume = 1,500 x 500 x 100 = 75 x 10^6 m^3.

Site I - Foya

This site situates on 2.0 km right side of the road towards Mendikoma through a swampy area. It is a range of mountains with clean tops and exposed homogeneous rock and a suitable site for economical haulage of materials toward site H and site J.

Estimated reserve: 1.0 km long, 200 m wide and 150 m height. Volume = 1,000 x 200 x 150 = 3 x 10^7 m^3.

Site J - Mendikoma

This site is located on the left side of the existing road at Mendikoma from Foya with a distance of about 20 meters from the road.

Though free from over-burden with homogeneous rock, this quarry site should be considered to be a spear side, because it situates almost at the end of this highway.

Estimated reserve: 1.0 km length, 400 m breast and 50 m height. Volume = 1,000 x 400 x 50 = 2 x 10^7 m^3.

The location of the above quarry sites is shown in DWG-II-2.

2.4.3 Specific Gravity of the Rock Specimen

The specific gravity was tested by MPW laboratory, and the results are shown as follows:

SAMPLE	SPECIFIC GRAVITY
A, B + C	2.61
D	2.63
E	2.64
J & G	2.69
H	2.64
I	2.64
J	2.62
Average	2.64

GBARNGA - MENDIKOMA HIGHWAY PROJECT FEASIBILITY STUDY | SHEET No.

LOCATION OF SAMPLING POINTS | DWG-II-1

DATE OF SAMPLING	SAMPLING POINTS
July 10, '79	G-1
11	G-2, G-3
12	G-4, G-11
14	Z-8, Z-10
16	Z-1, Z-7
20	V-6, V-9
21	V-1, V-8

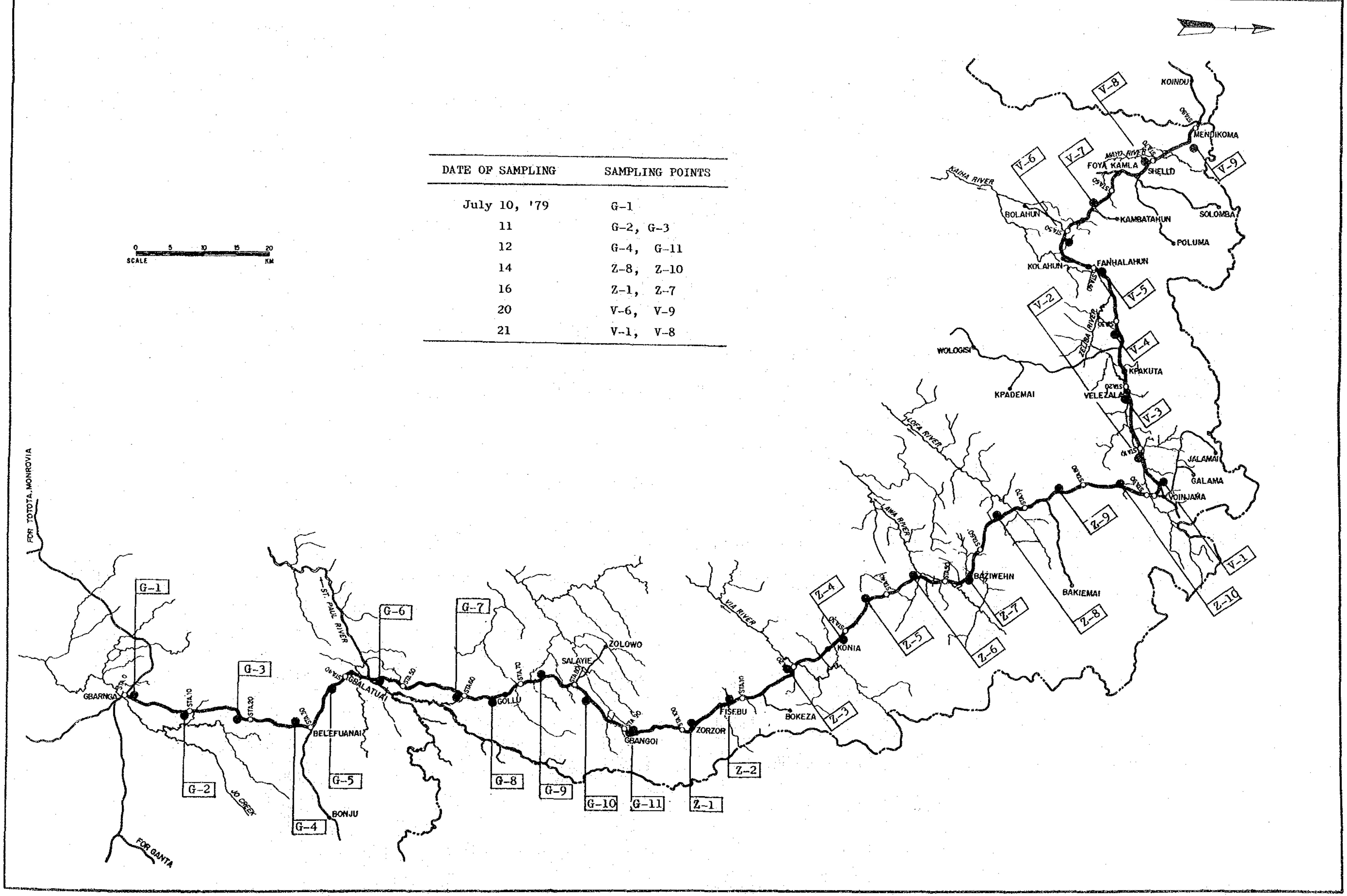


Table II-1 Discription about Soil Sample (1)

SAMPLE	DISTANCE & INTERVAL	RIGHT OR LEFT FOR MENDIKOMA	DEPTH FROM CUT SLOPE TOP	DEPTH FROM ROAD SURFACE	DESCRIPTIONS ABOUT SAMPLES
G-1	10m from Gbarnga Junction G.S	LEFT	0.5m (no slope section)	0 - 0.2m	Lateritic material including fine gravel (ϕ0.5 - 2.0cm). Red clay with a little iron oxides and mica.
				0.2m - 0.6m	Red plastic clay, hard milky red clay with silt, gravel (ϕ2.0cm) and mold in bottom layer.
G-2	9km from G-1	RIGHT	1.0m	0 - 0.2m	Dark brown wet surface soil with mold.
				0.2m - 0.6m	Dark brown gravelly clay with mold.
				0.6m - 1.0m	Dark brown gravelly silt with weathered rock.
G-3	9km from G-2	RIGHT	1.0m	0 - 0.5m	Moist brown medium to fine sand, some clay and silt, little medium to fine gravel,(ϕ0.5mm - 2.0mm), trace of decomposed rock fragments.
G-3'	near by G-3	RIGHT	0 m	1.0m HIGHT	Existing quarry site for selected laterite, mixture from gravel (0.5 - 2.0cm) and clay.
G-4	9km from G-3	LEFT	0.5m	0 - 0.2m	Red and hard lateritic material.
				0.2m - 1.0m	Wet tanish brown clayey silt and fine to coarse sand with mold.
G-5	9km from G-4	RIGHT	0.5m (embankment section)	0 - 0.5m	Moist light brown fine to coarse sand & clay and silt, trace of medium to fine gravel with mica, and mold.
G-6	9km from G-5	RIGHT	1.0m	0 - 0.5m	Moist tanish brown clay & silt, some fine to medium sand, little fine to medium gravel (ϕ5.0cm).
G-7	9km from G-6	RIGHT	1.5m	0 - 0.5m	Moist tanish brown fine to coarse sand, some medium to fine gravel & silt & clay gravel (ϕ10.0cm) in bottom of side ditch.
G-8	9km from G-7	RIGHT	2.0m	0 - 0.5m	Moist tanish brown fine to coarse sand, some silty clay & medium to fine gravel, trace of decomposed rock fragments.
G-9	9km from G-8	LEFT	4.0m	0 - 0.5m	Light brown silty clay with scoria (ϕ1mm - 3mm) gravel (ϕ12cm) with mold in bottom of side ditch.
G-10	9km from G-9	RIGHT	1.0m	0 - 0.5m	Moist light brown medium sandy clay and silt some gravel (ϕ10cm - 1cm) on cut slope.
G-11	9km from G-10	LEFT	2.0m	0 - 0.5m	Moist tan and brown fine to medium sand, some clay & silt fine gravel from weathered rock.
Z-1	800m from Zorzor G.S	LEFT	2.0m	0 - 0.5m	Moist tanish brown fine to coarse sand & clay & silt, little fine to medium gravel from weathered rock.
Z-2	9.3km from Z-1	LEFT	3.5m	0 - 0.8m	Moist red plastic clay, yellow harden silt, medium to coarse sand (ϕ0.5 - 2mm).
Z-3	9.3km from Z-2	LEFT	0.5m	0 - 0.5m	Moist greyish brown fine to medium sand, little silt with mold.

Table II-1 Discription about Soil Sample (2)

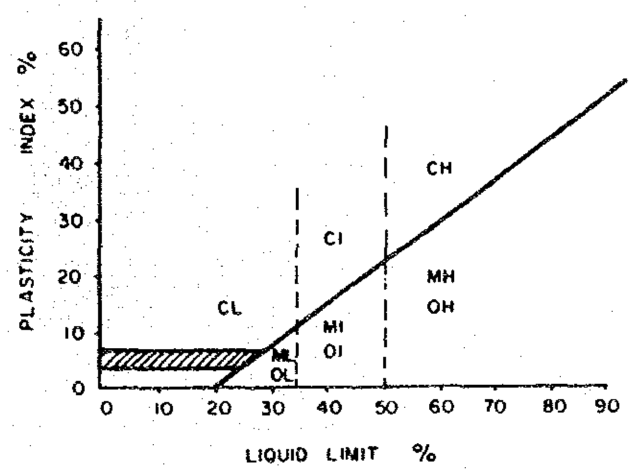
SAMPLE	DISTANCE & INTERVAL	RIGHT OR LEFT FOR MENDIKOMA	DEPTH FROM CUT SLOPE TOP	DEPTH FROM ROAD SURFACE	DESCRIPTIONS ABOUT SAMPLES
Z-4	9.3km from Z-3	RIGHT	3.0m	0 - 0.5m	Moist grey & brown fine to medium sand & clay & silt, trace of fine gravel.
Z-5	9.3km from Z-4	LEFT	0.5m	0 - 0.5m	Moist tan & brown medium to fine sand & silt & clay, trace of mold and scoria.
Z-6	9.3km from Z-5	LEFT	0.6m	0 - 0.3m	Red plastic clay with fine sand and gravel.
				0.3m - 0.6m	Moist tanish brown medium to coarse sand & silty clay, much medium to fine gravel, trace of mold and milky siet.
Z-7	9.3km from Z-6	RIGHT	0.8m	0 - 0.4m	Moist reddish brown clay with fine gravel from weathered rock.
				0.4m - 0.8m	Light yellow silt with sand and fine gravel from weathered rock.
Z-8	9.3km from Z-7	LEFT	1.5m	0 - 0.5m	Wet reddish brown medium to fine sand, some silt & clay, trace or roots & mica.
Z-9	9.3km from Z-8	LEFT	1.0m	0 - 0.3m	Moist dark grey sandy clay.
				0.3m - 0.5m	Moist reddish brown silt & clay and medium to find sand, trace of fine gravel and roots, light milky silt in bottom layer.
Z-10	9.3km from Z-9	LEFT	2.0m	0 - 0.5m	Moist tanish brown clay & silt, some fine to coarse sand, trace of fine gravel & roots, milky red clay and yellow silt.
V-1	4.6km from Voinjama G.S	RIGHT	0 m	0 m	Existing quarry for selected laterite, wet dark brown fine to coarse gravel, some medium to coarse sand & silt & clay, trace of mold & roots.
V-2	8.6km from V-1	LEFT	1.0m	0 - 0.2m	Dark grayish brown surface soil.
				0.2m - 1.0m	Moist light milkyish gray sandy clay, trace of roots and silt.
V-3	8.6km from V-2	LEFT	3.0m	0 - 0.5m	Moist dark red clay and fine to medium sand, trace of mica.
V-4	8.6km from V-3	LEFT	0.5m	0 - 0.5m	Moist red plastic clay with fine gravel (ϕ0.5-1.0cm) trace of barden silt and milky coarse gravel (ϕ5cm).
V-5	8.6km from V-4	RIGHT	2.0m	0 - 0.5m	Moist reddish brown medium to fine sand, some clayey silt, milkyish white clay, trace of roots and harden sand.
V-6	8.6km from V-5	RIGHT	0 m	0 m	Existing quarry for selected laterite. Moist tanish brown fine to medium gravel, some silty clay & fine to medium sand, trace of milky clay.
V-7	8.6km from V-6	LEFT	2.0m	0 - 0.5m	Wet reddish brown silt & clay and medium to fine sand, trace of roots, trace of sandstone and mica.
V-8	8.6km from V-7	LEFT	1.2m	0 - 0.3m	Moist red and brown medium to fine sand, some clay and silt, little decomposed rock fragments, trace of fine to medium gravel, trace of roots and siltstone.
V-9	8.6km from V-8	RIGHT	0 m	0 m	Moist dark red fine to medium gravel (ϕ1.0 - 3.0cm) some coarse to fine sand and silt, plastic red clay under 0.5m depth. Existing quarry for good lateritic material.

Table II-2 Summary of Soil Laboratory Test

LOCATION	SECTION	SAMPLE NO.	SAMPLE DEPTH (m)	GRAVEL %	SAND %	SILT & CLAY %	MAX DIAMETER (mm)	TYPE OF GRADING	LIQUID LIMIT LL (%)	PLASTIC LIMIT PL (%)	PLASTIC INDEX PI	SOIL CLASSIFICATION	NATURAL MOISTURE CONTENT Wn (%)	WET DENSITY t (g/cm^3)	DRY DENSITY d (g/cm^3)	TEST (AASHTO) CONDITION T 180	OPTIMUM MOISTURE CONTENT omc (%)	MAXIMUM DRY DENSITY dmax (g/cm^3)	TEST FOR SUBGRADE MATERIAL (%)	TEST FOR BASE MATERIAL %	DESIGN CBR
			GRADATION						CONSISTENCY				NATURAL STATE			COMPACTION			CBR TEST		
GBARNGA-ZORZOR	I	G-1	0.5	-	-	-	-	-	43.7	35.8	7.9	A-5	24.3	1,778	1.4	-	-	-	-	-	
		G-2	1.0	65.1	19.8	15.1	25.4	C	-	-	-	A-1-b	13.9	1,825	1.6	-	-	-	9.1	-	
		G-3	1.0	26.8	35.8	37.4	25.4	(E)	49.3	33.4	15.9	A-7	19.0	2,129	1.8	-	-	-	-	-	8
		G-4	0.5	4.6	37.5	57.9	9.5	F	26.8	24.2	2.6	A-4	19.5	2,015	1.7	-	-	-	8.1	-	
		G-5	0.5	18.5	39.9	41.6	19.1	(F)	54.0	22.8	31.2	A-7	22.3	1,915	1.6	-	-	-	-	-	
	II	G-6	1.0	37.3	23.6	39.1	19.1	(E)	36.4	23.6	12.8	A-6	25.1	1,884	1.5	C	13.8	1.92	19.0	-	
		G-7	1.5	38.1	34.6	27.3	19.1	(E~F)	37.8	22.3	15.5	A-2-6	13.2	2,050	1.8	-	-	-	-	-	
		G-8	2.0	34.9	38.9	26.2	25.4	(E~F)	42.2	18.1	24.1	A-2-7	13.3	1,897	1.7	-	-	-	20.7	-	8
		G-9	4.0	1.1	59.9	39.0	4.76	(F)	35.6	21.8	13.8	A-6	27.7	1,836	1.4	-	-	-	-	-	
		G-10	1.0	1.4	59.9	38.7	4.76	(F)	32.5	20.8	11.7	A-6	20.5	1,859	1.5	-	-	-	6.6	-	
		G-11	2.0	22.5	45.7	31.2	19.1	D	37.5	26.9	10.6	A-2-6	24.8	1,694	1.4	-	-	-	-	-	
ZORZOR-VOINJAMA	III	Z-1	2.0	24.6	32.2	43.2	19.1	(F)	51.1	34.5	16.6	A-7	22.7	1,983	1.6	-	-	-	17.4	-	
		Z-2	3.5	19.2	36.8	44.0	12.7	(F)	46.4	27.1	19.3	A-7	20.2	2,000	1.7	-	-	-	-	-	
		Z-3	0.5	3.4	60.3	36.3	9.5	(E~F)	26.8	16.4	10.4	A-4	12.9	2,019	1.8	C	10.6	2.00	15.7	-	
		Z-4	3.0	17.0	36.8	46.2	12.7	(F)	-	-	-	A-7	20.8	2,015	1.7	-	-	-	-	-	7
		Z-5	0.5	8.4	41.4	50.2	4.76	(F)	47.1	31.0	16.1	A-7	21.6	2,004	1.7	-	-	-	6.6	-	
		Z-6	0.6	21.6	44.0	34.4	25.4	(F)	56.6	31.3	25.3	A-2-7	16.7	2,017	1.7	-	-	-	-	-	
		Z-7	0.8	13.1	32.2	54.7	25.4	(F)	37.2	27.0	10.2	A-2-4	21.9	2,006	1.7	-	-	-	8.3	-	
		Z-8	1.5	4.9	73.3	21.9	9.5	F	55.4	30.8	24.6	A-2-7	26.7	1,848	1.5	-	-	-	-	-	
	IV	Z-9	1.0	16.5	35.1	48.4	19.1	(F)	38.4	24.1	14.3	A-6	17.8	2,057	1.8	-	-	-	8.3	-	
		Z-10	2.0	-	-	-	-	-	-	-	-	-	21.9	1,955	1.6	-	-	-	6.6	-	
VOINJAMA-MENDEKOMA		V-1	0	57.0	19.6	23.4	25.4	D	52.8	23.5	29.3	A-2-7	14.9	2,095	1.8	-	-	-	-	-	
		V-2	1.0	0.4	58.1	41.5	4.76	(F)	3.8	21.9	16.9	A-6	17.5	1,933	1.7	C	14.0	1.86	5.8	-	
		V-3	3.0	-	-	-	-	-	-	-	-	-	26.1	1,752	1.4	-	-	-	-	-	4
		V-4	0.5	16.3	40.9	42.9	9.5	F	42.4	28.2	14.2	A-7	20.0	1,891	1.6	-	-	-	-	-	
		V-5	2.0	2.9	67.7	29.4	9.5	F	38.6	22.0	16.6	A-2-6	24.2	1,926	1.6	-	-	-	6.6	-	
		V-6	0	41.9	28.2	29.9	19.1	D	56.2	29.2	27.0	A-2-7	17.7	2,014	1.7	-	-	-	-	-	
		V-7	2.0	2.4	34.5	63.1	4.76	(F)	51.6	44.5	7.1	A-5	33.5	1,848	1.4	-	-	-	4.6	-	
	V	V-8	1.2	13.0	55.3	31.7	19.1	F	38.9	25.5	13.4	A-2-6	16.1	2,103	1.8	-	-	-	13.2	-	
		V-9	0	52.1	16.6	31.5	25.4	(D)	36.8	27.7	10.1	A-2-4	22.6	2,211	1.8	-	-	-	-	-	11
		V-9'	0.5	-	-	-	-	-	-	-	-	-	35.2	1,870	1.4	-	-	-	-	-	
		G-3 & V-9	-	47.5	25.4	27.1	19.1	(D)	42.1	29.7	12.4	A-2-7	-	-	-	-	16.2	1.89	-	63/49	

Table II-3 Extended Unified Soil Classifications System to laterite soils

CLASSIFICATIONS TO BE MADE ON ALL SOIL MATERIALS									Soundness classification to be made on aggregates if desired
LESS THAN 50% PASSING THE # 200 SIEVE	ROCK	Gravel or rock greater than 8 inches				Boulder	Large crushed or weathered rock fragments		
		Gravel or rock between 3 inches and 8 inches				Cobble	Medium sized crushed or weathered rock fragments		
	GRAVEL	Gravel or rock smaller than 3" in which the majority of the material retained on the # 200 sieve is also retained on the # 4 sieve	CLEAN	≤ 5 % Passing # 200	$C_u > 4$, $1 \le C_c \le 3$	GW	Well graded gravels with very few fines		Perform the California Coarse Durability Test** on the natural, or as used, grading of the 3/4" to #4 fraction of the material. Add symbol: $D_c > 35$ use symbol (1); $20 \le D_c \le 35$ use symbol (2); $D_c < 20$ use symbol (3) i.e., GCL (2)
						GP	Poorly graded gravels with very few fines		
			DIRTY	6 - 12 % Passing # 200	$C_u > 4$, $1 \le C_c \le 3$	GW/---	Well graded gravels with silt or clay fines	Classify minus # 40 material as for clay and silt below. Add the appropriate symbol in the location indicated by dashes; i.e., GW/CL or GC1	
						GP/---	Poorly graded gravels with silt or clay fines		
			EXCESS FINES	> 12 % Passing # 200		GM---	Gravel - sand - silt mixtures of variable plasticity		
						GC---	Gravel - sand - clay mixtures of variable plasticity		
	SAND	Majority of the material retained on the # 200 sieve passes the # 4 sieve	CLEAN	≤ 5 % Passing # 200	$C_u > 6$, $1 \le C_c \le 3$	SW	Well graded sands with very few fines		Perform the California Fines Durability Test** on the natural, or as used, grading of the minus # 4 material. Add symbol: $D_f > 35$ use symbol (1); $20 \le D_f \le 35$ use symbol (2); $D_f < 20$ use symbol (3)
						SP	Poorly graded sands with very few fines		
			DIRTY	6 - 12 % Passing # 200	$C_u > 6$, $1 \le C_c \le 3$	SW/--	Well graded sands with clay or silt fines	Classify minus # 40 material as for clay and silt below. Add the appropriate symbol in the location indicated by dashes; i.e., SP/ML or SMH	
						SP/--	Poorly graded sands with clay or silt fines		
			EXCESS FINES	> 12 % Passing # 200		SM---	Clayey - silty sands of variable plasticity		
						SC---	Very sandy clays and clayey sands of variable plasticity		
50% OR MORE PASSING THE #200 SIEVE	CLAY AND SILT	Non - Plastic	Atterberg limits unobtainable			SF	Very fine sands, sandy - silts, silts		
		LL of minus # 40 material < 35	Atterberg limits plot above 'A'			CL	Inorganic clayey silts, clays of low plasticity		
			Atterberg limits plot below 'A' line or in hatched area			ML	Inorganic silts, and rock flour of low compressibility		
						OL	Organic silts and clays		
		LL of minus # 40 material 35 to 50	Atterberg limits plot above 'A'			CI	Inorganic clays of moderate plasticity		
			Atterberg limits plot below 'A' line			MI	Inorganic silty clays, moderately compressible silts		
						OI	Organic clays and clays		
		LL of minus # 40 material > 50	Atterberg limits plot above 'A' line			CH	Inorganic clays of high plasticity		
			Atterberg limits plot below 'A' line			MH	Highly compressible silts, micaceous or diatomaceous soils		
						OH	Organic clays and clays		
Decaying organic soils usually brown or black possibly with strong odor						P_T	Fibrous organic soils with very high compressibility and moisture content		



* $C_u = \frac{D_{60}}{D_{10}}$, $C_c = \frac{(D_{30})^2}{D_{60} D_{10}}$, the term D_{10}, etc., means the diameter of the particle corresponding to the 10% passing point on the plot of grain size versus percent passing

** California State Highway Department, Materials Division, Sacramento, California, Test Procedure 229

Dc = Coarse durability for gravels.
Df = Fine durability for sands.
Cc = Coefficient of curvature.
Cu = Coefficient of uniformity.

Source: Laterite Soil Engineering by M.D. Gidigasu

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	G − 4	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR)	(m ~ m)	TESTED BY (ESSAI PAR)	

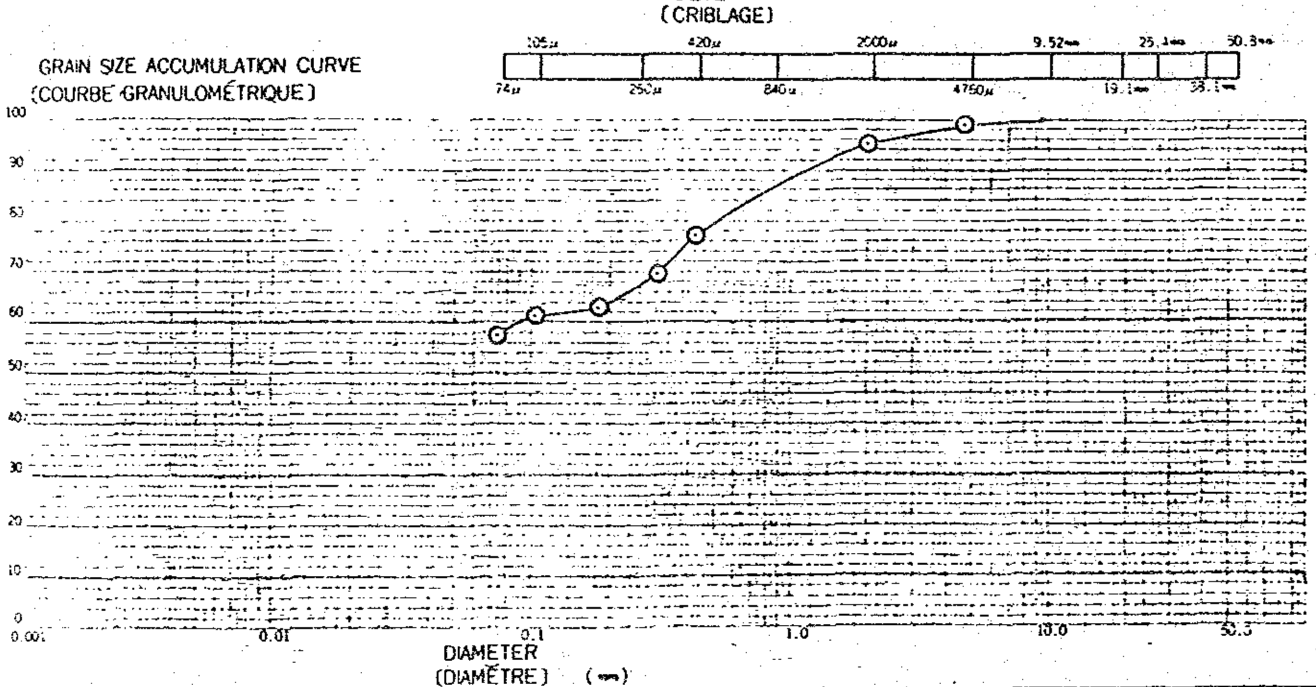
FOR REPORTING (POUR LE RAPPORT)

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	~~38.1~~ 25.4	~~25.4~~ 19.1	~~19.1~~ 12.7	9.52	4.76	2.00	~~0.84~~ 0.42	~~0.42~~ 0.30	~~0.25~~ 0.18	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)					100	99.4	95.4	77.1	69.9	63.0	61.5	57.9
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												

GRAIN SIZE ACCUMULATION CURVE (COURBE GRANULOMÉTRIQUE)



*	CLAY (ARGILE)	SILT (SILT)	SAND (SABLE)	GRAVEL (GRAVIER)

0.001 0.005 0.074 2.0

* COLLOID (COLLOÏDE)

PROPORTION (PROPORTION)				
4.76mm <	0.6 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	9.5 mm
4.76 ~ 2.00mm	4.0 %	60% DIAMETER (DIAMÈTRE 60%)	0.091 mm
2.00 ~ 0.42mm	18.3 %	30% DIAMETER (DIAMÈTRE 30%)	mm
0.42 ~ 0.074mm	19.2 %	10% DIAMETER (DIAMÈTRE 10%)	mm
0.074 ~ 0.005mm	57.9 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	G − 8	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR)	(m ~ m)	TESTED BY (ESSAI PAR)	

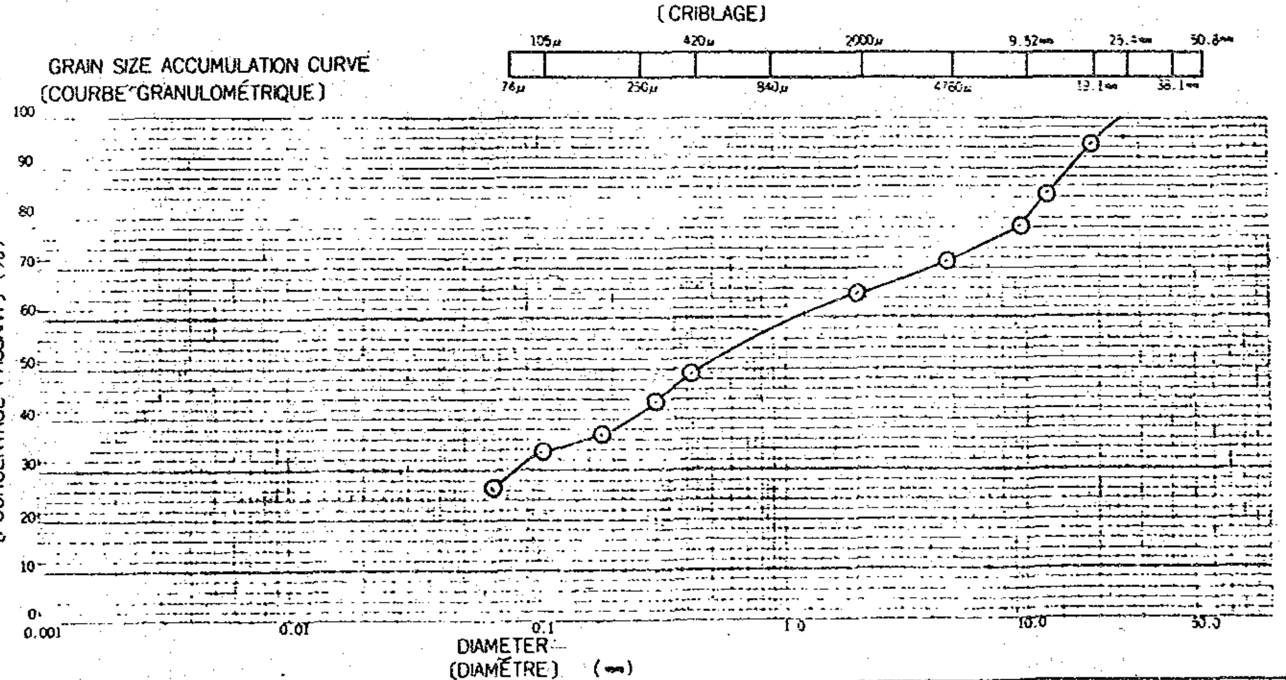
FOR REPORTING (POUR LE RAPPORT)

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	~~38.1~~ 25.4	~~25.4~~ 19.1	~~19.1~~ 12.7	9.52	4.76	2.00	~~0.84~~ 0.42	~~0.42~~ 0.30	~~0.25~~ 0.18	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)		100	96.2	84.4	78.2	71.2	65.1	49.3	43.9	36.7	33.9	26.2
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												

GRAIN SIZE ACCUMULATION CURVE (COURBE GRANULOMÉTRIQUE)



*	CLAY (ARGILE)	SILT (SILT)	SAND (SABLE)	GRAVEL (GRAVIER)

0.001 0.005 0.074 2.0

* COLLOID (COLLOÏDE)

PROPORTION (PROPORTION)				
4.76mm <	28.8 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	25.4 mm
4.76 ~ 2.00mm	6.1 %	60% DIAMETER (DIAMÈTRE 60%)	11.0 mm
2.00 ~ 0.42mm	15.8 %	30% DIAMETER (DIAMÈTRE 30%)	0.08 mm
0.42 ~ 0.074mm	23.1 %	10% DIAMETER (DIAMÈTRE 10%)	mm
0.074 ~ 0.005mm	26.2 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)

FOR REPORTING (POUR LE RAPPORT)

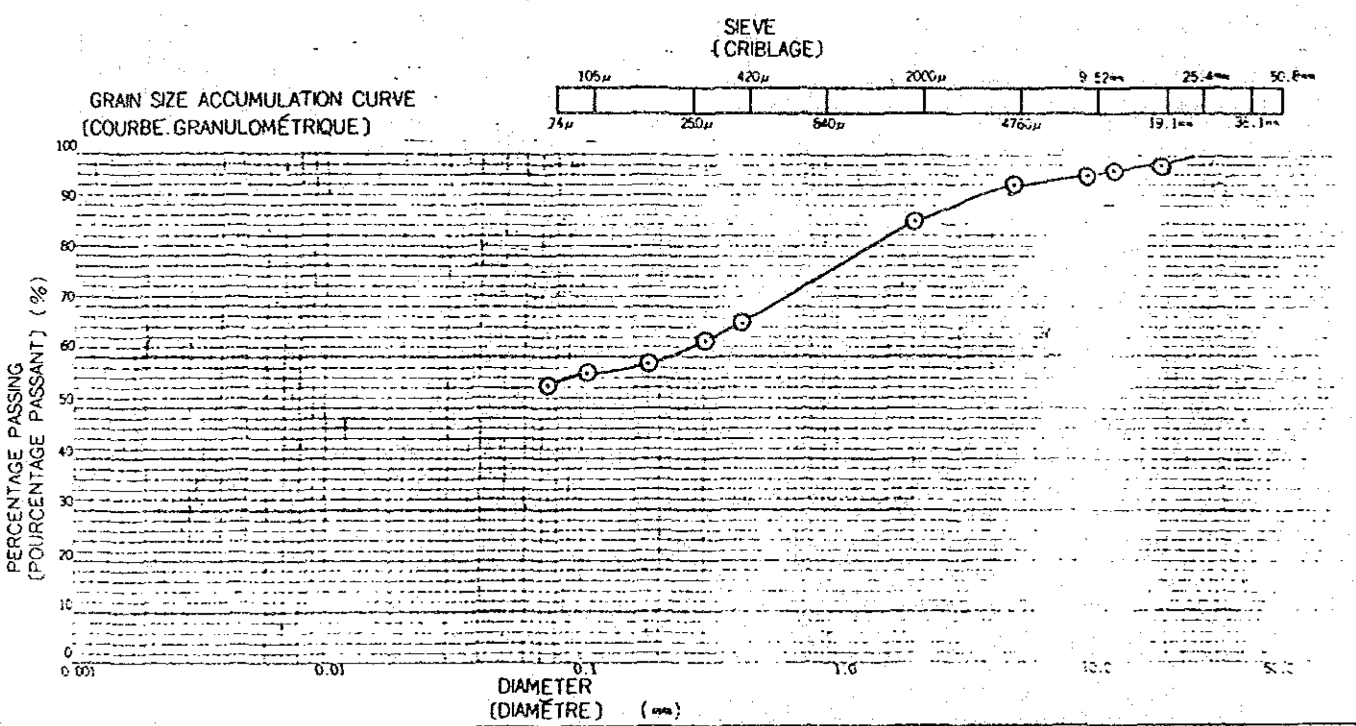
NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	Z-7	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR)	(m~ m)	TESTED BY (ESSAI PAR)	

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	~~38.1~~ 25.4	~~25.4~~ 19.1	~~19.1~~ 12.7	9.52	4.76	2.00	~~0.84~~ 0.42	~~0.42~~ 0.30	~~0.25~~ 0.18	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)		100	97.8	97.4	96.9	94.3	86.9	66.7	63.5	58.8	57.4	54.7
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												

GRAIN SIZE ACCUMULATION CURVE (COURBE GRANULOMÉTRIQUE)



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

* COLLOID (COLLOÏDE)

PROPORTION (PROPORTION)				
4.76mm <	5.7 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	25.4	mm
4.76~2.00mm	7.4 %	60% DIAMETER (DIAMÈTRE 60%)	0.22	mm
2.00~0.42mm	20.2 %	30% DIAMETER (DIAMÈTRE 30%)		mm
0.42~0.074mm	12.0 %	10% DIAMETER (DIAMÈTRE 10%)		mm
0.074~0.005mm	54.7 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)		
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)		

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)

FOR REPORTING (POUR LE RAPPORT)

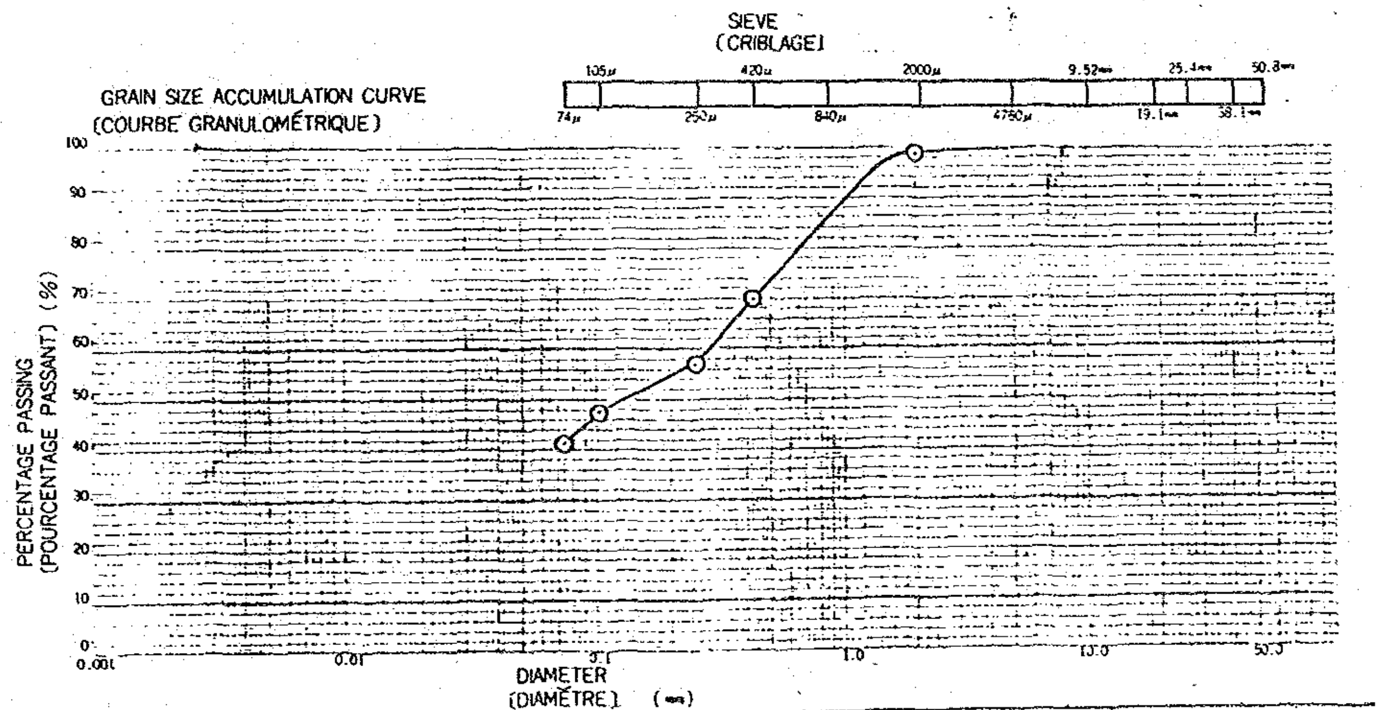
NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	V-2	DATE (DATE)	
SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR)	(m~ m)	TESTED BY (ESSAI PAR)	

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	~~38.1~~ 25.4	~~25.4~~ 19.1	~~19.1~~ 12.7	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)						100	99.6	—	70.0	57.2	47.9	41.5
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												

GRAIN SIZE ACCUMULATION CURVE (COURBE GRANULOMÉTRIQUE)



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

* COLLOID (COLLOÏDE)

PROPORTION (PROPORTION)				
4.76mm <	0 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	4.76	mm
4.76~2.00mm	0.4 %	60% DIAMETER (DIAMÈTRE 60%)	0.29	mm
2.00~0.42mm	29.6 %	30% DIAMETER (DIAMÈTRE 30%)		mm
0.42~0.074mm	28.5 %	10% DIAMETER (DIAMÈTRE 10%)		mm
0.074~0.005mm	41.5 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)		
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)		

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)

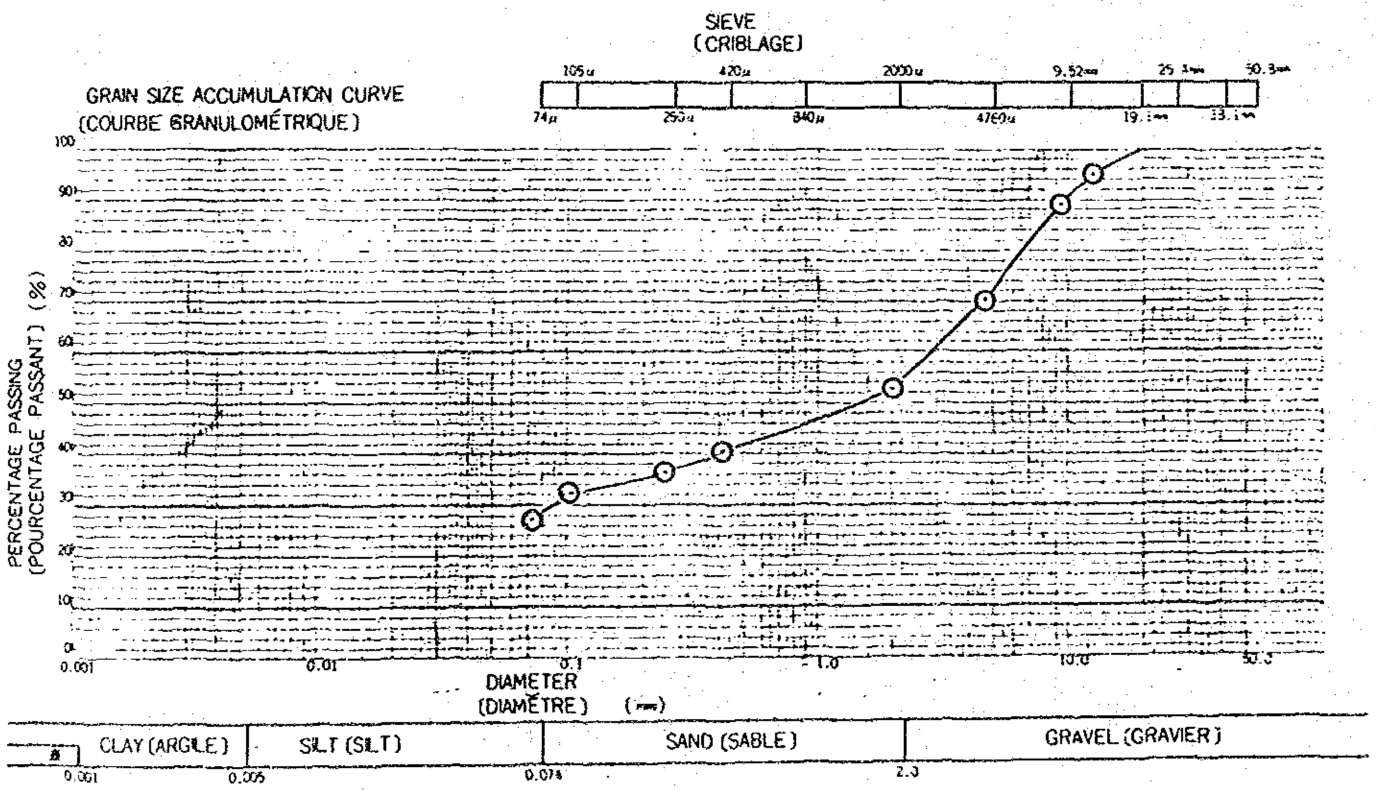
FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	G-3 & V-9	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	~~19.1~~ 12.7	9.52	4.76	2.00	0.84	0.42	0.25	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)			100	95.0	87.3	70.4	52.5	—	40.5	36.3	32.1	27.1
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												



✱ COLLOID (COLLOÏDE)

PROPORTION (PROPORTION)				
4.76mm <	29.6 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	19.1 mm
4.76 ~ 2.00mm	17.9 %	60% DIAMETER (DIAMÈTRE 60%)	2.9 mm
2.00 ~ 0.42mm	12.0 %	30% DIAMETER (DIAMÈTRE 30%)	0.09 mm
0.42 ~ 0.074mm	13.4 %	10% DIAMETER (DIAMÈTRE 10%)	mm
0.074 ~ 0.005mm	27.1 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

GRADATION ANALYSIS (ANALYSE GRANULOMÉTRIQUE)

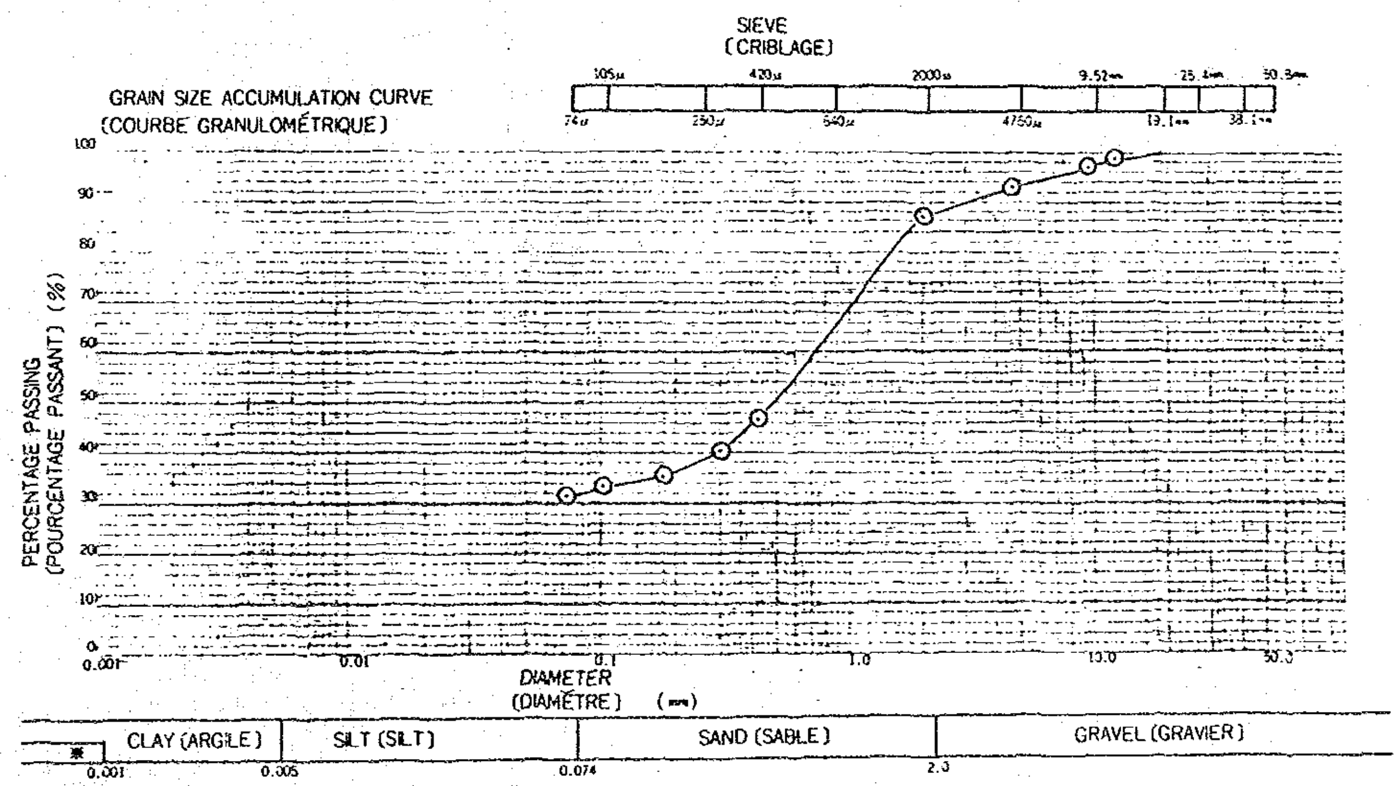
FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)	V – 8	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	~~38.1~~ 25.4	~~25.4~~ 19.1	~~19.1~~ 12.7	9.52	4.76	2.00	~~0.84~~ 0.42	~~0.42~~ 0.30	~~0.25~~ 0.18	0.105	0.074
	TOTAL PASSING (%) (TOTAL PASSANT)			100	98.8	97.1	93.4	87.0	46.6	40.5	35.5	33.9	31.7
HYDROMETER (ARÉOMÉTRIE)	GRAIN SIZE (mm) (GRANULOMÉTRIE)												
	TOTAL PASSING (%) (TOTAL PASSANT)												



✱ COLLOID (COLLOÏDE)

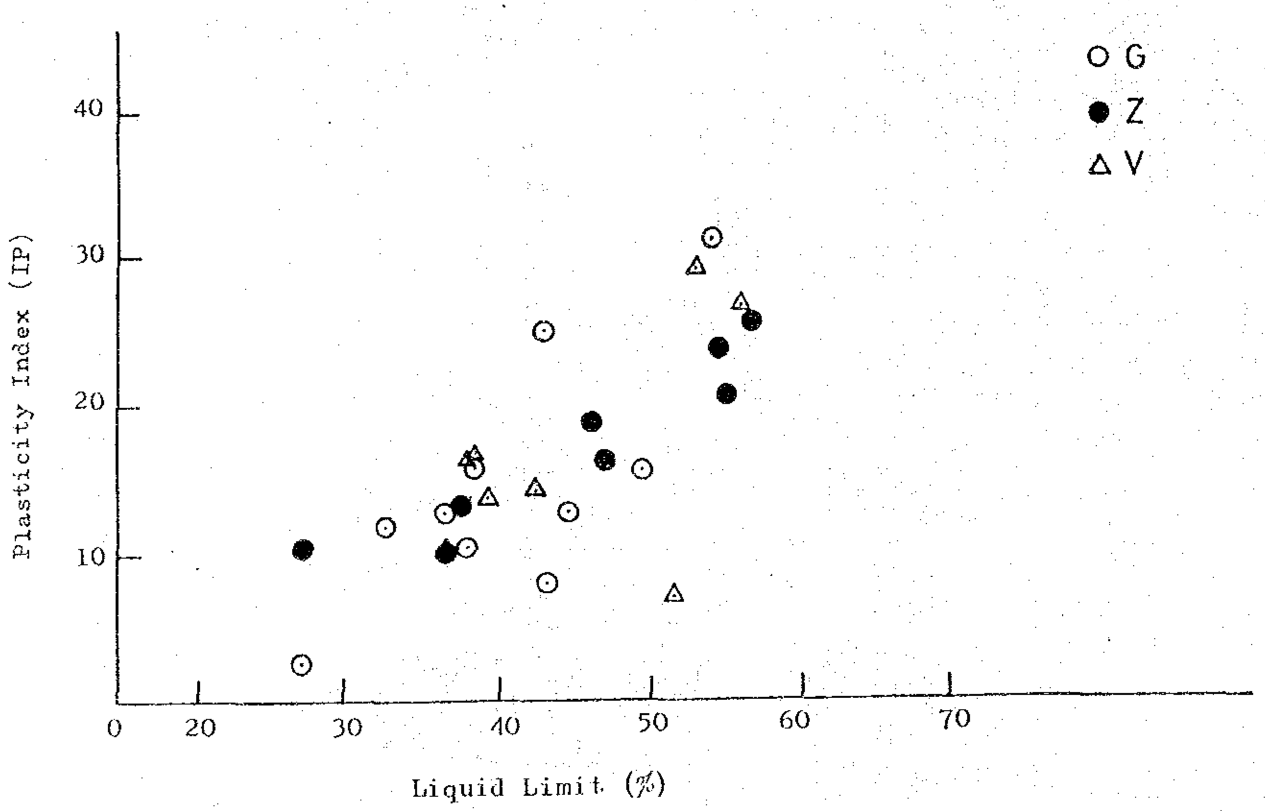
PROPORTION (PROPORTION)				
4.76mm <	6.6 %	MAXMUM DIAMETER (DIAMÈTRE MAXIMUM)	19.1 mm
4.76 ~ 2.00mm	6.4 %	60% DIAMETER (DIAMÈTRE 60%)	0.73 mm
2.00 ~ 0.42mm	40.4 %	30% DIAMETER (DIAMÈTRE 30%)	mm
0.42 ~ 0.074mm	14.9 %	10% DIAMETER (DIAMÈTRE 10%)	mm
0.074 ~ 0.005mm	31.7 %	COEFFICIENT OF UNIFORMITY (COEFFICIENT D'UNIFORMITÉ)	
0.005mm >	%	COEFFICIENT OF CURVATURE (COEFFICIENT DE COURBURE)	

Test Result (4)

The corelation of Liquid Limit (W_L) and Plasticity Index (Ip) is given below.

Ip of the most of samples is over than 6 ranging 10 to 25, which is required for subbase course materials in AASHTO M 147-65.

Six (6) results from all test results are picked up and shown hereunder



LIQUID LIMIT & PLASTIC LIMIT TEST
(ESSAI DE LIMITE DE LIQUIDITÉ ET DE LIMITE DE PLASTICITÉ)

FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)			
DATE (DATE)		TESTED BY (ESSAI PAR)	

SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR): No. G-4 (m~ m)

LIQUID LIMIT TEST (LIMITE DE LIQUIDITÉ)			PLASTIC LIMIT TEST (LIMITE DE PLASTICITÉ)	
TEST. NO (N° DE L'ESSAI)	NO. OF BLOWS (NOMBRE DE COUP)	WATER CONTENT (TENEUR EN EAU)	TEST. NO (N° DE L'ESSAI)	WATER CONTENT (TENEUR EN EAU)
1	33	25.4 %	1	23.7 %
2	28	26.3 %	2	24.6 %
3	22	27.4 %	3	%
4	17	28.9 %		
5		%		
6		%	MEAN VALUE (VALEUR MOYENNE)	24.2

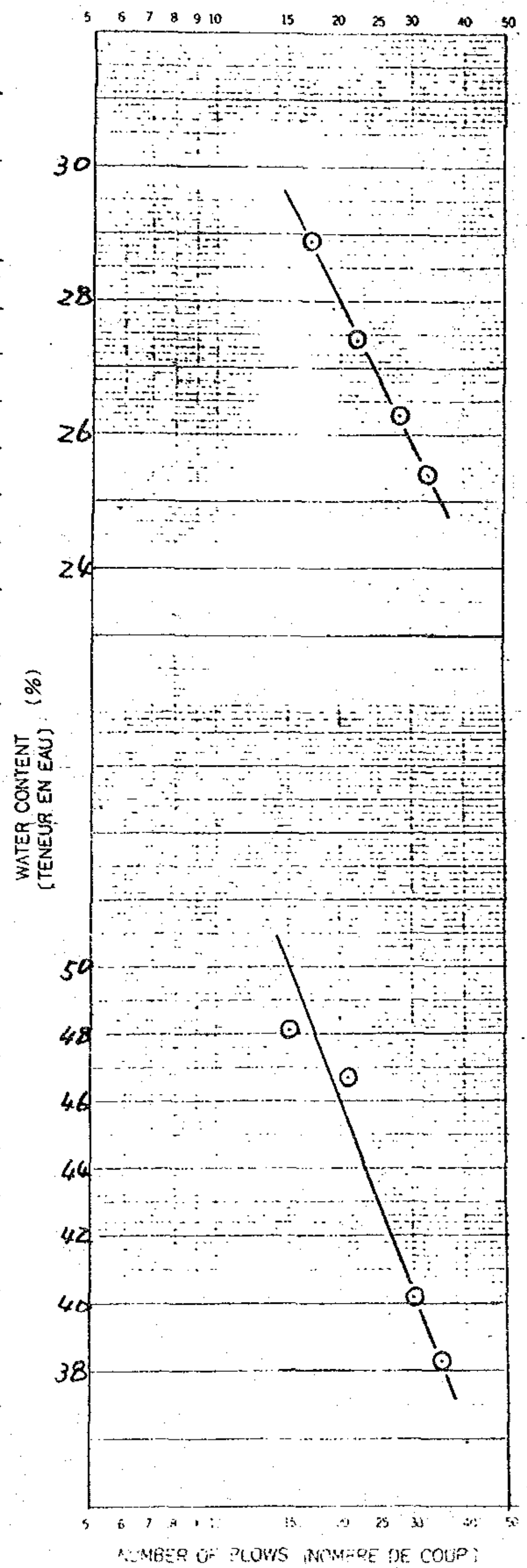
LIQUID LIMIT (LIMITE DE LIQUIDITÉ)	PLASTIC LIMIT (LIMITE DE PLASTICITÉ)	PLASTICITY INDEX (INDICE DE PLASTICITÉ)
w_L 26.8 %	w_p 24.2 %	I_p 2.6

SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR): No. G-8 (m~ m)

LIQUID LIMIT TEST (LIMITE DE LIQUIDITÉ)			PLASTIC LIMIT TEST (LIMITE DE PLASTICITÉ)	
TEST. NO (N° DE L'ESSAI)	NO. OF BLOWS (NOMBRE DE COUP)	WATER CONTENT (TENEUR EN EAU)	TEST. NO (N° DE L'ESSAI)	WATER CONTENT (TENEUR EN EAU)
1	35	38.3 %	1	18.2 %
2	30	40.2 %	2	18.0 %
3	21	46.7 %	3	%
4	15	48.1 %		
5		%		
6		%	MEAN VALUE (VALEUR MOYENNE)	18.1

LIQUID LIMIT (LIMITE DE LIQUIDITÉ)	PLASTIC LIMIT (LIMITE DE PLASTICITÉ)	PLASTICITY INDEX (INDICE DE PLASTICITÉ)
w_L 43.0 %	w_p 18.1 %	I_p 24.9

FLOW CURVE
(COURBE DE DÉTERMINATION DE LA LIMITE DE LIQUIDITÉ)



LIQUID LIMIT & PLASTIC LIMIT TEST
(ESSAI DE LIMITE DE LIQUIDITÉ ET DE LIMITE DE PLASTICITÉ)

FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)			
DATE (DATE)		TESTED BY (ESSAI PAR)	

SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR): No. Z − 7 (m ~ m)

LIQUID LIMIT TEST (LIMITE DE LIQUIDITÉ)			PLASTIC LIMIT TEST (LIMITE DE PLASTICITÉ)	
TEST NO. (N° DE L'ESSAI)	NO. OF BLOWS (NOMBRE DE COUP)	WATER CONTENT (TENEUR EN EAU)	TEST NO. (N° DE L'ESSAI)	WATER CONTENT (TENEUR EN EAU)
1	30	35.1 %	1	26.7 %
2	24	37.4 %	2	27.3 %
3	20	38.4 %	3	%
4	15	39.7 %		
5		%		
6		%	MEAN VALUE (VALEUR MOYENNE)	27.0

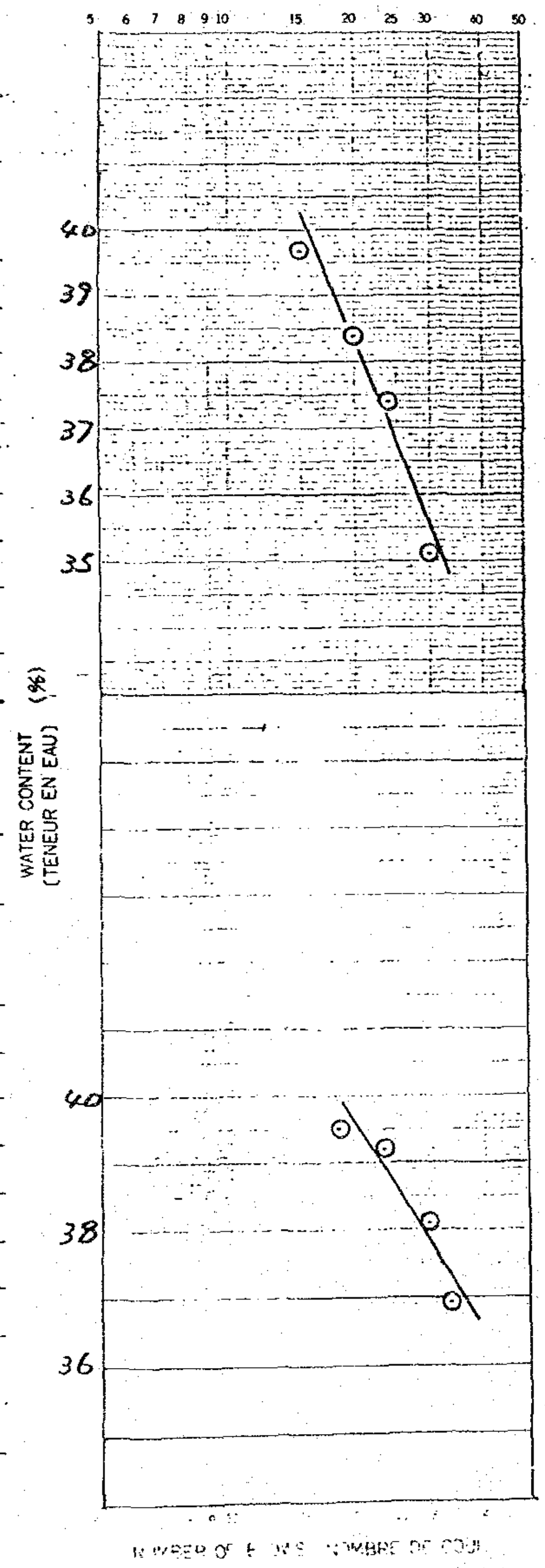
LIQUID LIMIT (LIMITE DE LIQUIDITÉ)	PLASTIC LIMIT (LIMITE DE PLASTICITÉ)	PLASTICITY INDEX (INDICE DE PLASTICITÉ)
w_L 36.8 %	w_p 27.0 %	I_p 9.8

SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR): No. V − 2 (m ~ m)

LIQUID LIMIT TEST (LIMITE DE LIQUIDITÉ)			PLASTIC LIMIT TEST (LIMITE DE PLASTICITÉ)	
TEST NO. (N° DE L'ESSAI)	NO. OF BLOWS (NOMBRE DE COUP)	WATER CONTENT (TENEUR EN EAU)	TEST NO. (N° DE L'ESSAI)	WATER CONTENT (TENEUR EN EAU)
1	33	36.9 %	1	20.8 %
2	29	38.1 %	2	22.9 %
3	23	39.2 %	3	%
4	18	39.5 %		
5		%		
6		%	MEAN VALUE (VALEUR MOYENNE)	21.9

LIQUID LIMIT (LIMITE DE LIQUIDITÉ)	PLASTIC LIMIT (LIMITE DE PLASTICITÉ)	PLASTICITY INDEX (INDICE DE PLASTICITÉ)
w_L 38.5 %	w_p 21.9 %	I_p 16.6

FLOW CURVE (COURBE DE DÉTERMINATION DE LA LIMITE DE LIQUIDITÉ)



LIQUID LIMIT & PLASTIC LIMIT TEST
(ESSAI DE LIMITE DE LIQUIDITÉ ET DE LIMITE DE PLASTICITÉ)

FOR REPORTING (POUR LE RAPPORT)

NAME OF SURVEY & LOCALITY (DÉNOMINATION DE L'ENQUÊTE ET LOCALITÉ)			
DATE (DATE)		TESTED BY (ESSAI PAR)	

SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR): No. V − 8 (m ~ m)

LIQUID LIMIT TEST (LIMITE DE LIQUIDITÉ)			PLASTIC LIMIT TEST (LIMITE DE PLASTICITÉ)	
TEST NO. (N° DE L'ESSAI)	NO. OF BLOWS (NOMBRE DE COUP)	WATER CONTENT (TENEUR EN EAU)	TEST NO. (N° DE L'ESSAI)	WATER CONTENT (TENEUR EN EAU)
1	35	35.8 %	1	25.3 %
2	29	37.9 %	2	25.6 %
3	24	40.6 %	3	%
4	16	43.4 %		
5		%		
6		%	MEAN VALUE (VALEUR MOYENNE)	25.5

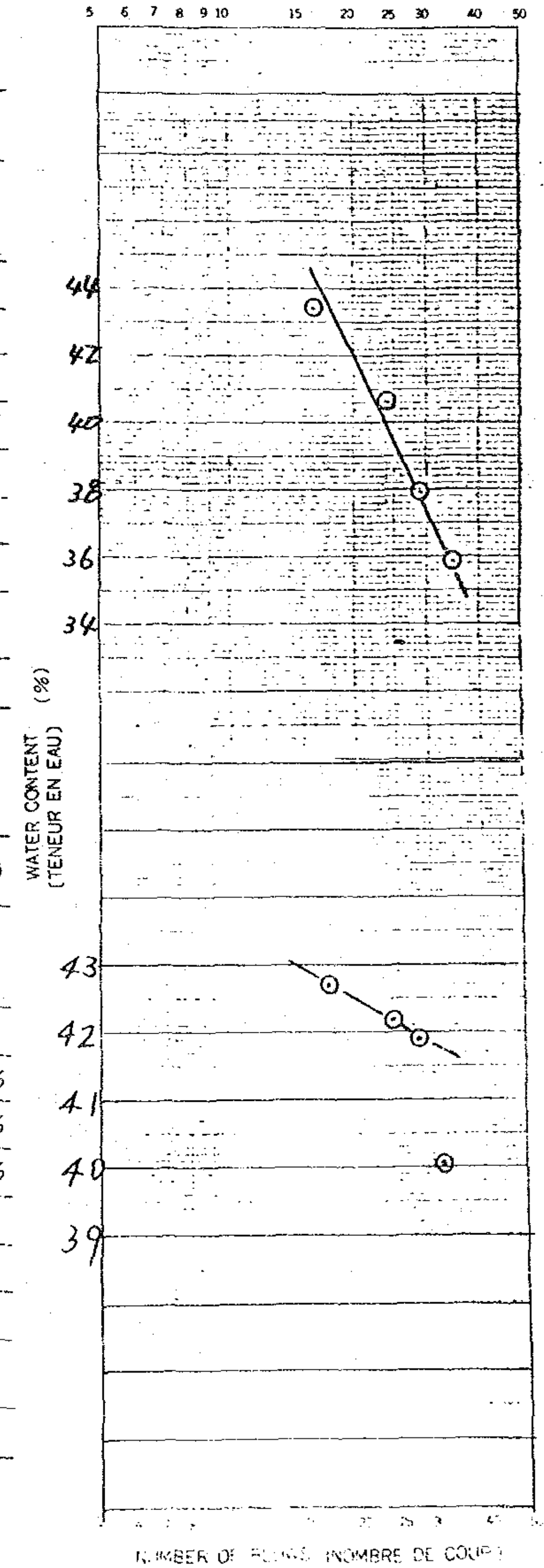
LIQUID LIMIT (LIMITE DE LIQUIDITÉ)	PLASTIC LIMIT (LIMITE DE PLASTICITÉ)	PLASTICITY INDEX (INDICE DE PLASTICITÉ)
w_L 39.4 %	w_p 25.5 %	I_p 13.9

SAMPLE NO. & DEPTH (N° DE L'ÉCHANTILLON ET PROFONDEUR): No. G − 3 & V − 9 (m ~ m)

LIQUID LIMIT TEST (LIMITE DE LIQUIDITÉ)			PLASTIC LIMIT TEST (LIMITE DE PLASTICITÉ)	
TEST NO. (N° DE L'ESSAI)	NO. OF BLOWS (NOMBRE DE COUP)	WATER CONTENT (TENEUR EN EAU)	TEST NO. (N° DE L'ESSAI)	WATER CONTENT (TENEUR EN EAU)
1	32	40.6 %	1	30.5 %
2	28	41.9 %	2	28.9 %
3	24	42.2 %	3	%
4	17	42.7 %		
5		%		
6		%	MEAN VALUE (VALEUR MOYENNE)	29.7

LIQUID LIMIT (LIMITE DE LIQUIDITÉ)	PLASTIC LIMIT (LIMITE DE PLASTICITÉ)	PLASTICITY INDEX (INDICE DE PLASTICITÉ)
w_L %	w_p %	I_p

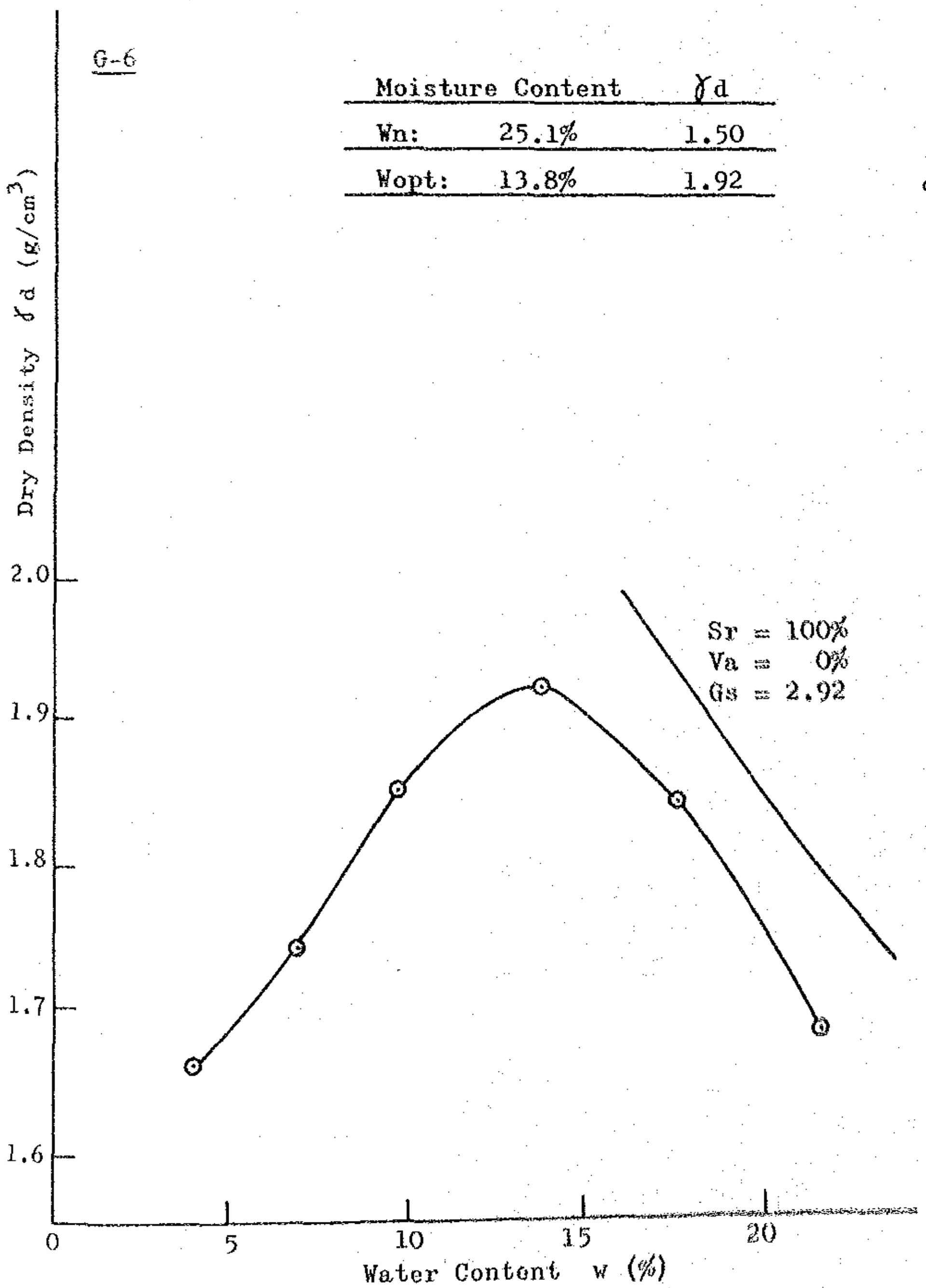
FLOW CURVE (COURBE DE DÉTERMINATION DE LA LIMITE DE LIQUIDITÉ)

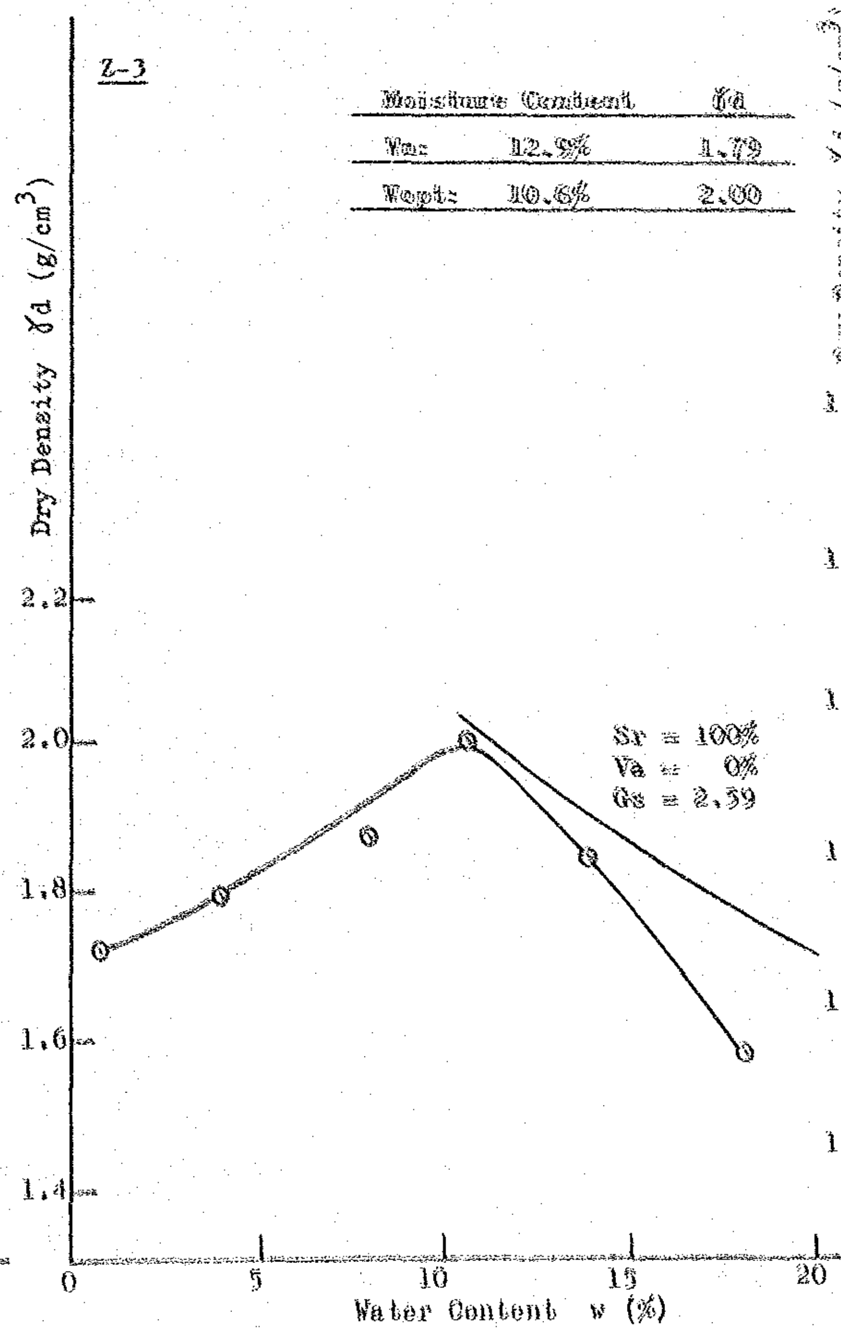


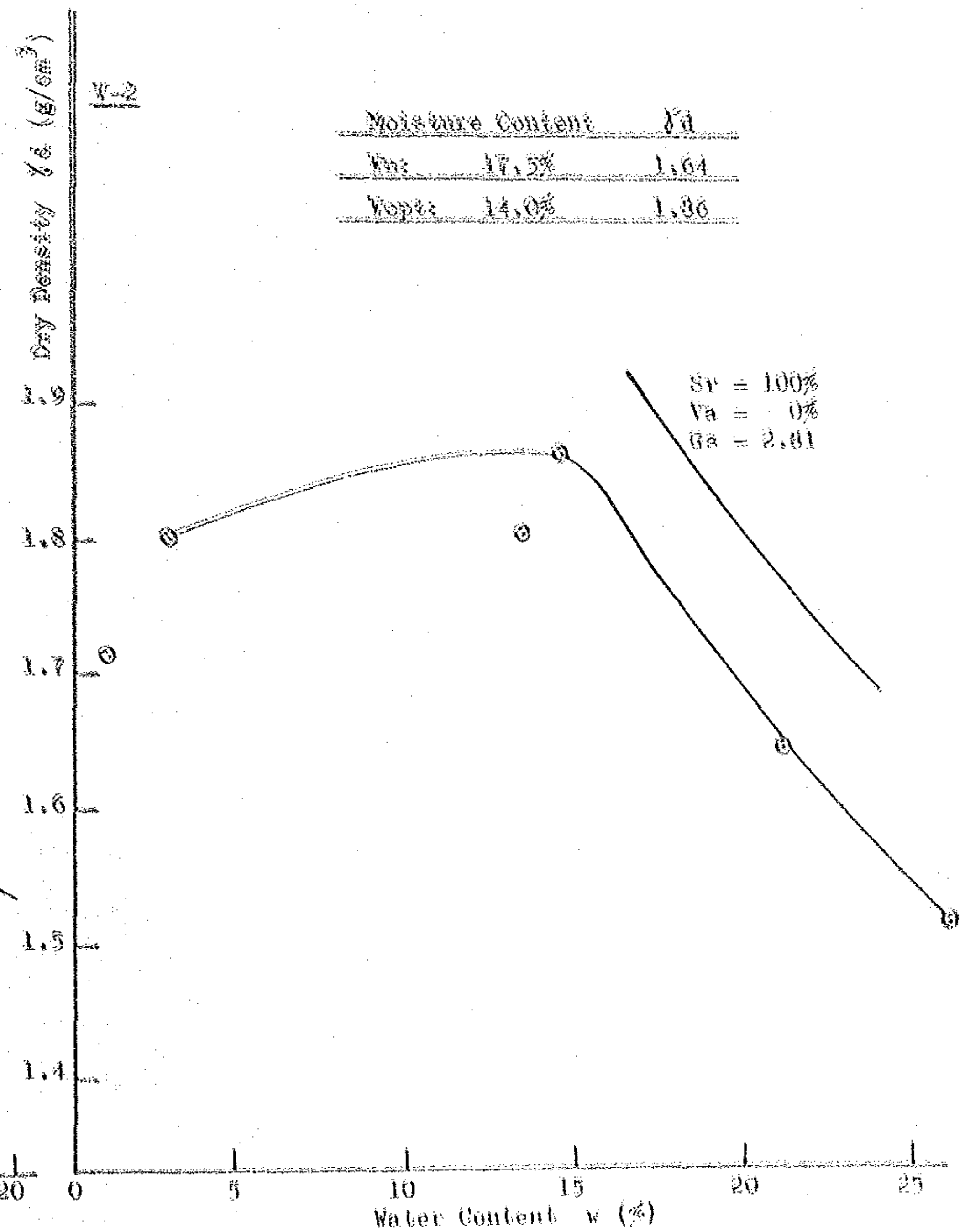
 Compaction Test

The following three (3) samples were tested as the typical sample of each stretch;

G-6 for Gbarnga-Zorzor, Z-3 for Zorzor-Voinjama, V-2 for Voinjama-Mendikoma.

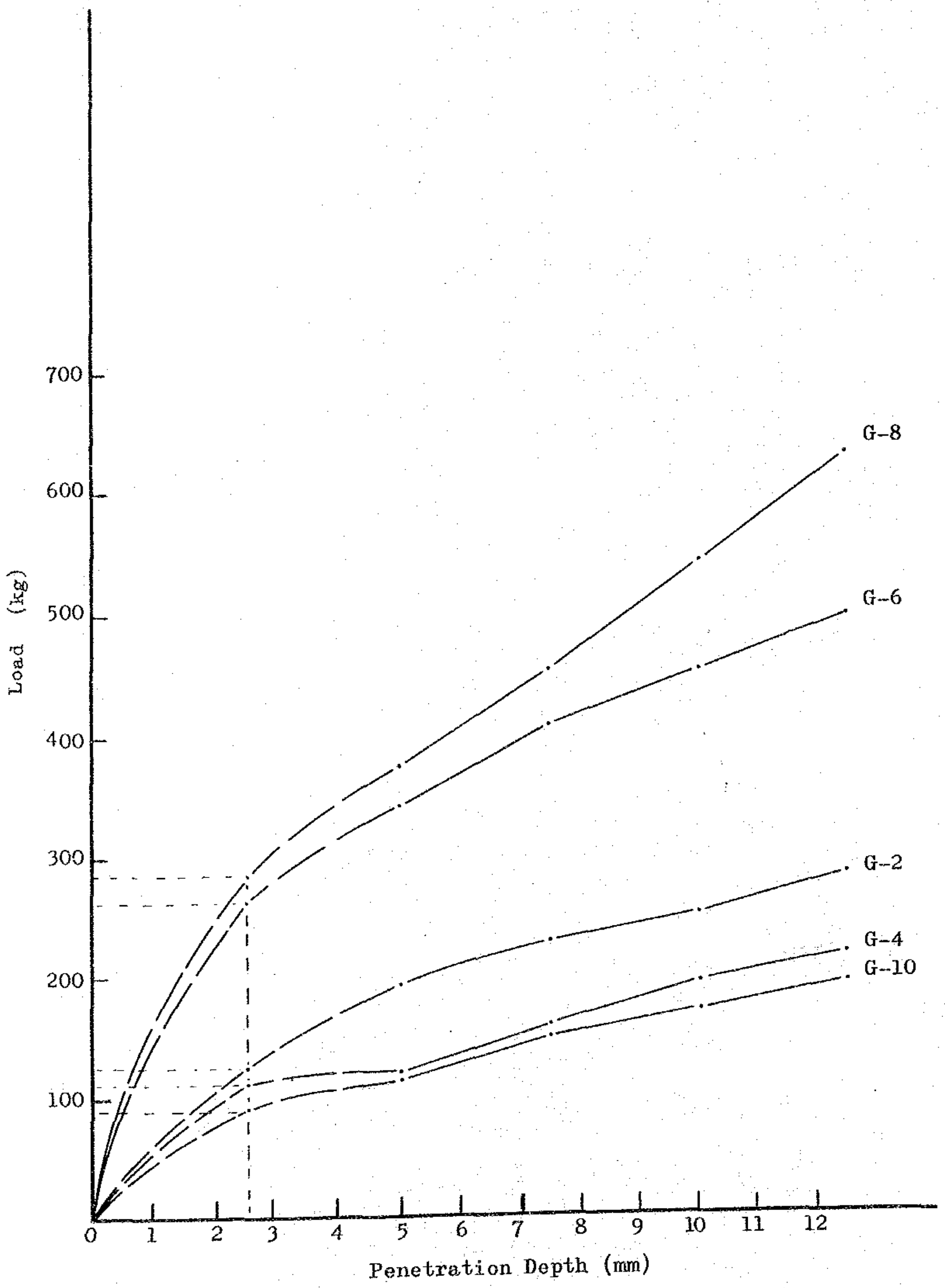






Test Result (7)

CBR Test for Gbarnga-Zorzor Stretch



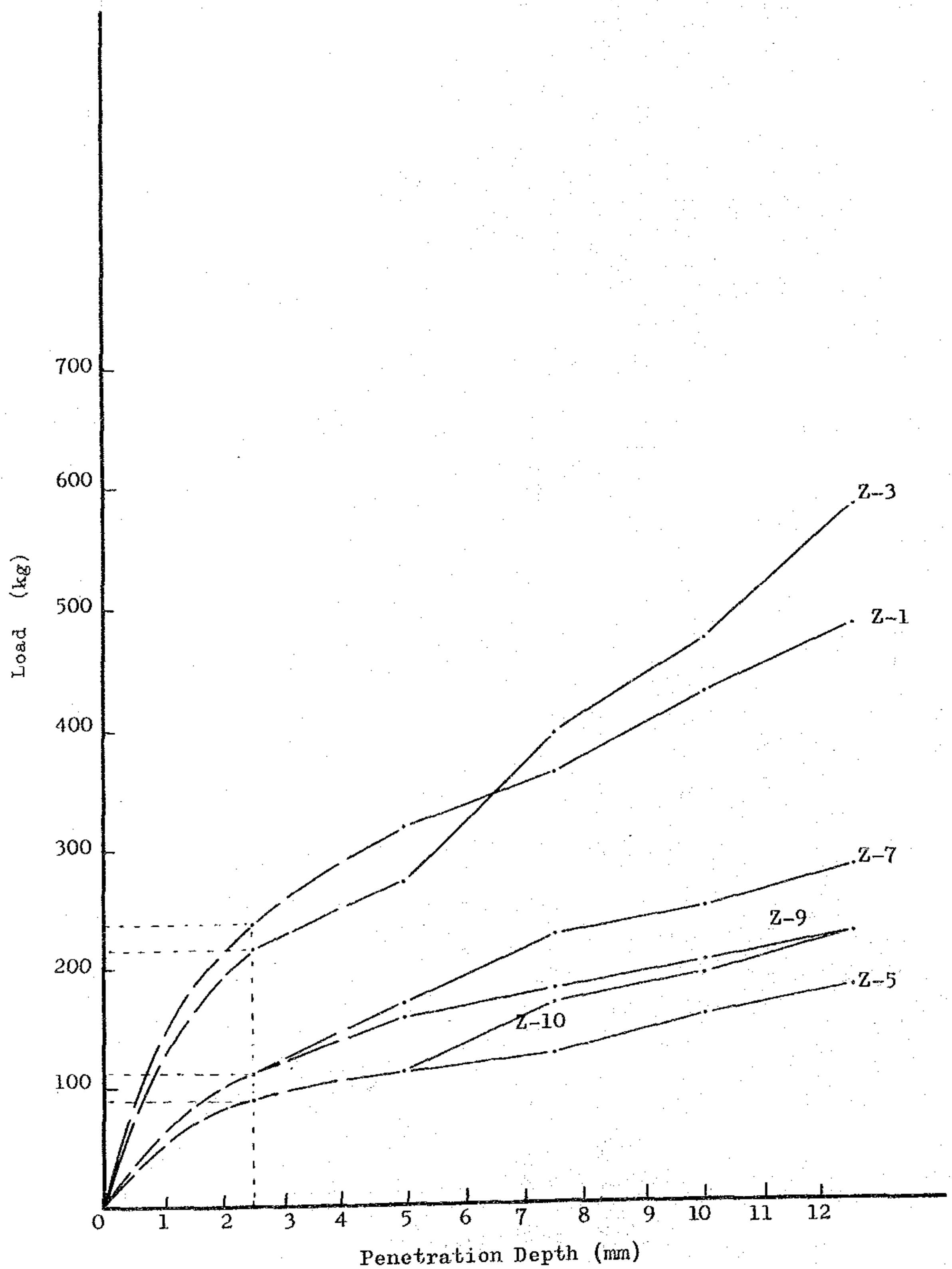
$$CBR = \frac{\text{Actual Load}}{\text{Standard Load}} \times 100\%$$

G-2	$CBR_{2.5} = \frac{124.7}{1370} \times 100 = 9.1\ \%$ *	
	$CBR_{5.0} = \frac{192.8}{2030} \times 100 = 9.5\ \%$	
G-4	$CBR_{2.5} = \frac{111.1}{1370} \times 100 = 8.1\ \%$	
	$CBR_{5.0} = \frac{120.0}{2030} \times 100 = 5.9\ \%$	
G-6	$CBR_{2.5} = \frac{260.8}{1370} \times 100 = 19.0\ \%$	
	$CBR_{5.0} = \frac{340.2}{2030} \times 100 = 16.8\ \%$	
G-8	$CBR_{2.5} = \frac{283.5}{1370} \times 100 = 20.7\ \%$	
	$CBR_{5.0} = \frac{374.2}{2030} \times 100 = 18.4\ \%$	
G-10	$CBR_{2.5} = \frac{90.7}{1370} \times 100 = 6.6\ \%$	
	$CBR_{5.0} = \frac{113.4}{2030} \times 100 = 5.6\ \%$	

Note: $CBR_{2.5}$ is value at 0.1 in(2.5) penetration,
and $CBR_{5.0}$ is value at 0.2 in(5.0) penetration.
The CBR is generally selected at 0.1 in(2.5) penetration.

Test Result (8)

CBR Test for Zorzor-Voinjama Stretch

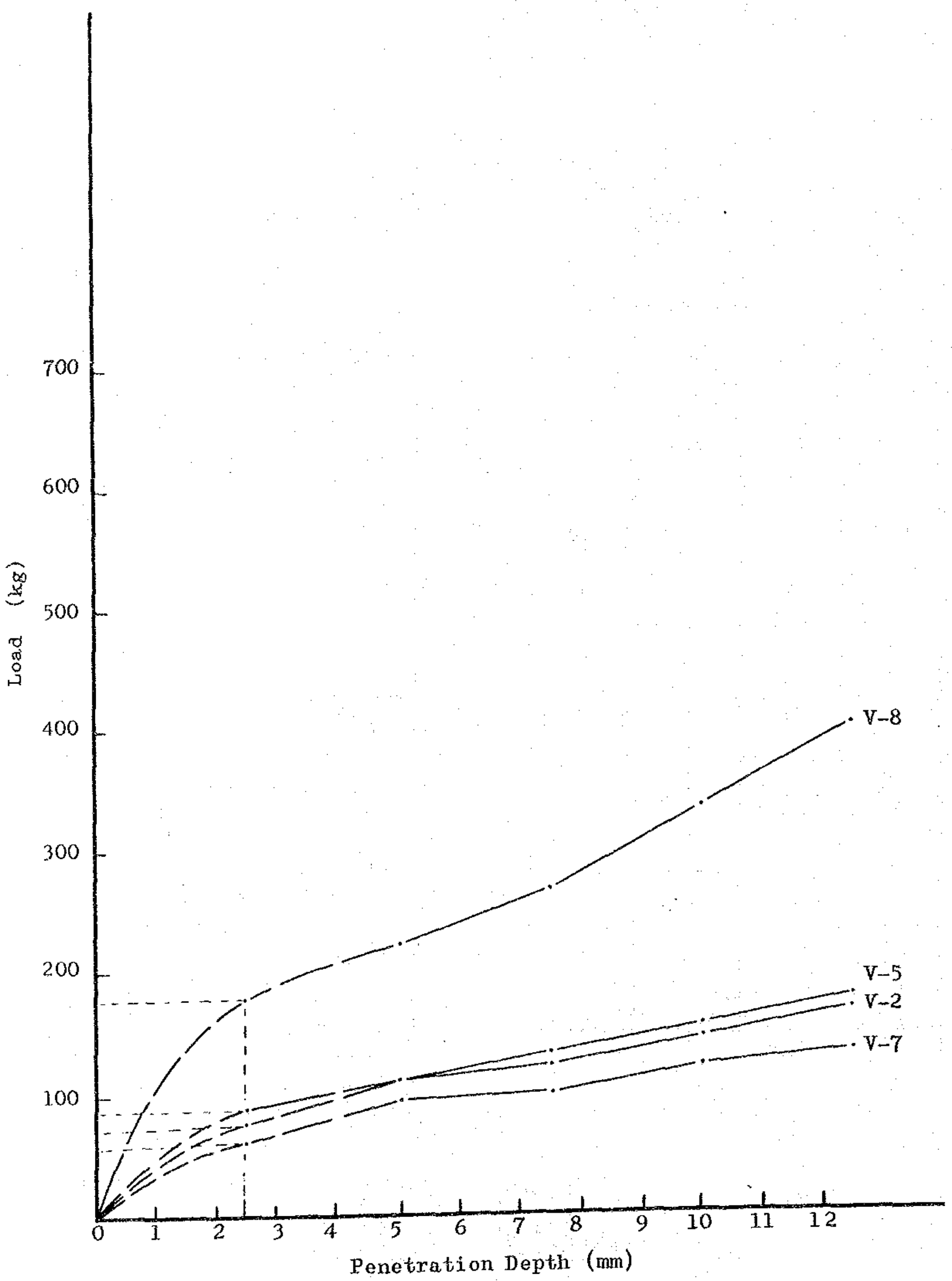


$$CBR = \frac{\text{Actual Load}}{\text{Standard Load}} \times 100\%$$

Z-1	$CBR_{2.5}$	=	$\frac{238.1}{1370}$	x	100	=	17.4 %
	$CBR_{5.0}$	=	$\frac{317.5}{2030}$	x	100	=	15.6 %
Z-3	$CBR_{2.5}$	=	$\frac{215.5}{1370}$	x	100	=	15.7 %
	$CBR_{5.0}$	=	$\frac{272.7}{2030}$	x	100	=	13.4 %
Z-5	$CBR_{2.5}$	=	$\frac{90.7}{1370}$	x	100	=	6.6 %
	$CBR_{5.0}$	=	$\frac{113.4}{2030}$	x	100	=	5.6 %
Z-7	$CBR_{2.5}$	=	$\frac{113.4}{1370}$	x	100	=	8.3 % *
	$CBR_{5.0}$	=	$\frac{170.1}{2030}$	x	100	=	8.4 %
Z-9	$CBR_{2.5}$	=	$\frac{113.4}{1370}$	x	100	=	8.3 %
	$CBR_{5.0}$	=	$\frac{158.8}{2030}$	x	100	=	7.8 %
Z-10	$CBR_{2.5}$	=	$\frac{90.7}{1370}$	x	100	=	6.6 %
	$CBR_{5.0}$	=	$\frac{130}{2030}$	x	100	=	6.4 %

Test Result (9)

CBR Test for Voinjama-Mendikoma Stretch



$$CBR = \frac{\text{Actual Load}}{\text{Standard Load}} \times 100\%$$

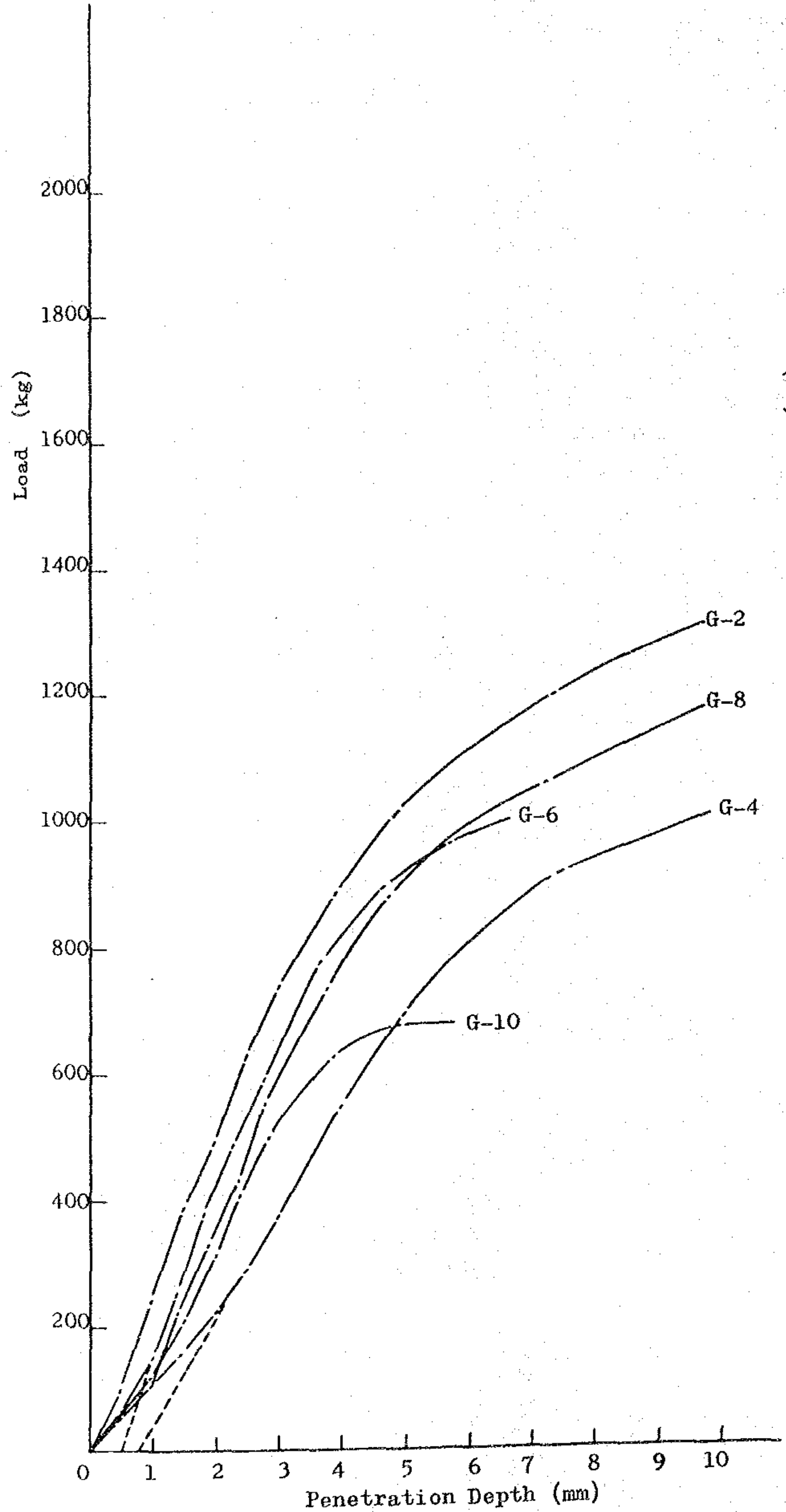
V-2	$CBR_{2.5}$	=	$\frac{79.4}{1370} \times 100$	=	5.8 %
	$CBR_{5.0}$	=	$\frac{113.4}{2030} \times 100$	=	5.6 %
V-5	$CBR_{2.5}$	=	$\frac{90.7}{1370} \times 100$	=	6.6 %
	$CBR_{5.0}$	=	$\frac{113.4}{2030} \times 100$	=	5.6 %
V-7	$CBR_{2.5}$	=	$\frac{63.5}{1370} \times 100$	=	4.6 %
	$CBR_{5.0}$	=	$\frac{79.4}{2030} \times 100$	=	3.9 %
V-8	$CBR_{2.5}$	=	$\frac{181.4}{1370} \times 100$	=	13.2 %
	$CBR_{5.0}$	=	$\frac{226.8}{2030} \times 100$	=	11.2 %

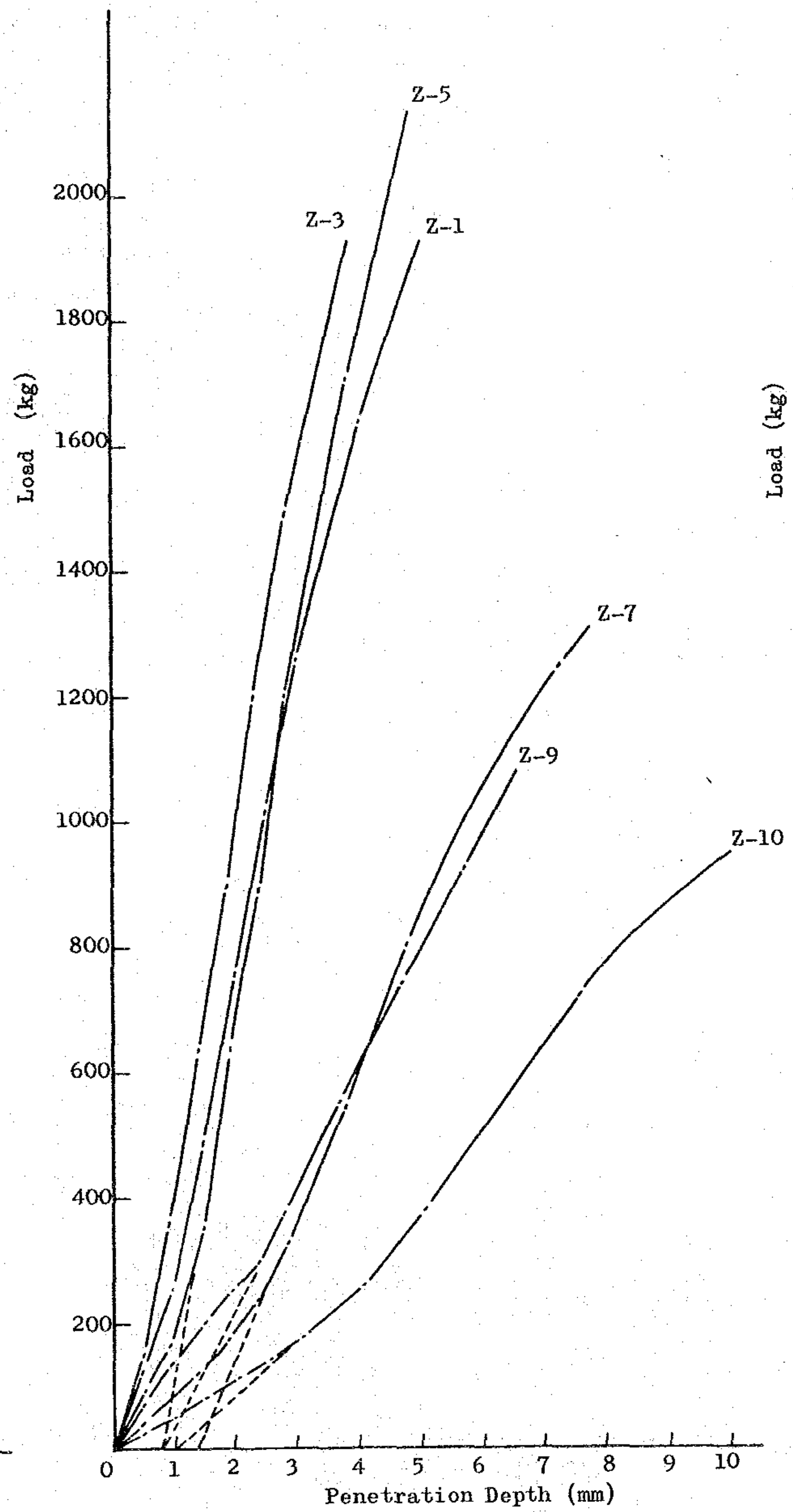
Table II-4 Summary of Road Surface Test

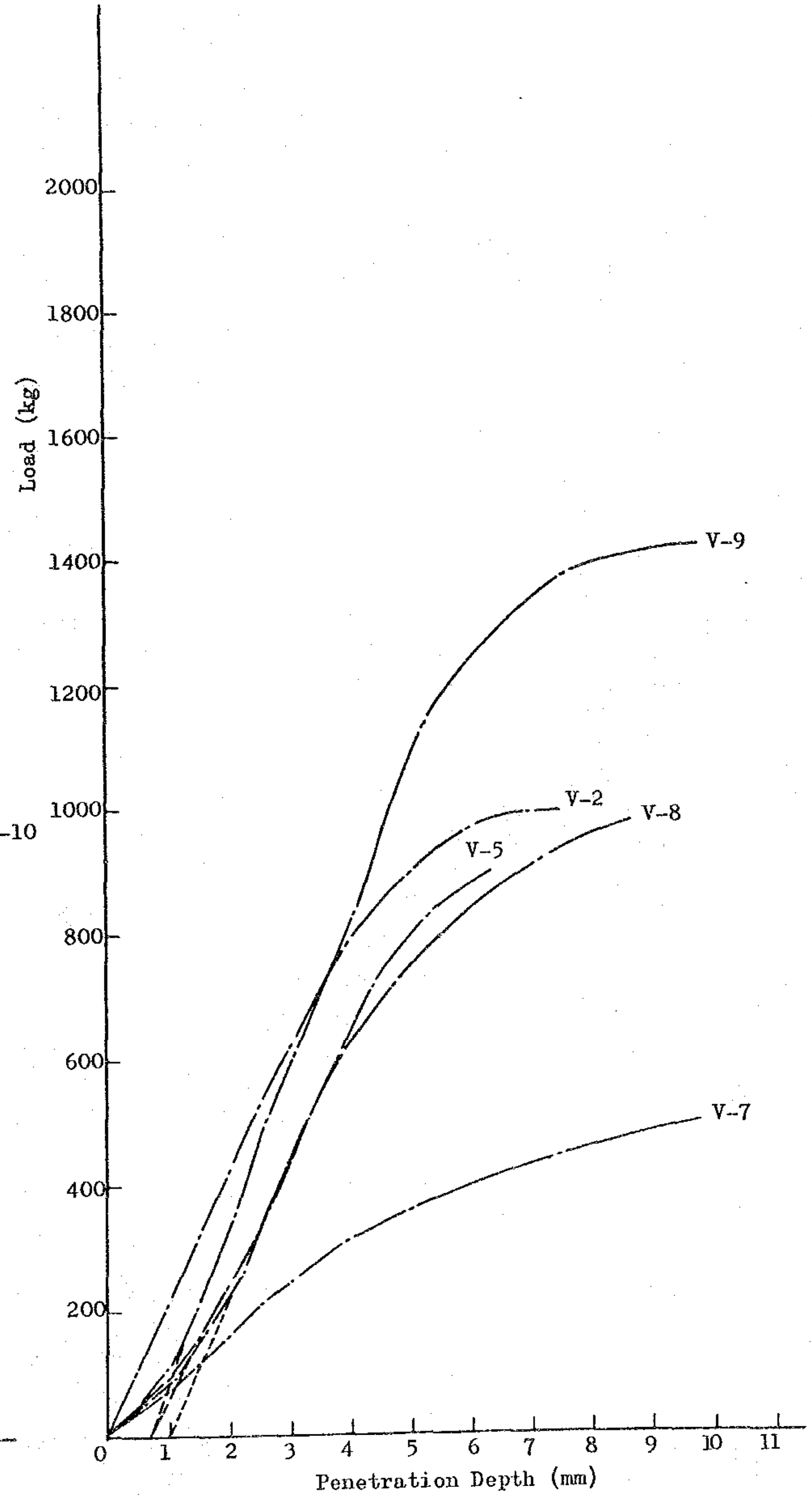
TEST ITEMS \ LOCATION		Gbarnga-Zorzor					Zorzor-Voinjama						Voinjama-Mendekoma				
Sample Point		G-2	G-4	G-6	G-8	G-10	Z-1	Z-3	Z-5	Z-7	Z-9	Z-10	V-2	V-5	V-7	V-8	V-9
Sample Depth (m)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C.B.R. Test	Natural Moisture Content (%)	10.7	15.0	10.6	6.1	8.9	8.9	3.3	6.2	11.1	10.1	9.4	8.0	8.3	18.0	8.4	11.8
C.B.R. Test	Field C.B.R. (%)	46.4	30.7	46.7	42.4	38.0	74.6	94.9	108.0	42.3	34.3	16.1	38.9	39.4	15.4	35.8	49.6
Benkelman Beam Test	Initial Dial Reading (mm)	2.3 / 2.5	2.2 / 2.0	1.0 / 1.4	0.7 / 0.2	3.1 / 2.5	2.4 / 2.3	1.7 / 0.8	2.2 / 2.5	3.7 / 2.5	1.1 / 1.7	0.6 / 1.0	3.5 / 3.6	2.4 / 4.2	3.8 / 4.3	3.8 / 3.4	2.6 / 2.3
Benkelman Beam Test	Final Dial Reading (mm)	0.6 / 0.9	1.2 / 1.0	0.7 / 1.4	0.7 / 0.2	2.6 / 1.8	2.4 / 2.0	1.3 / 0.8	1.5 / 2.4	2.2 / 1.0	0.6 / 0.7	0.2 / 1.0	3.1 / 2.7	2.4 / 4.2	1.6 / 2.3	2.2 / 2.1	1.8 / 1.7
Benkelman Beam Test	Total Rebound Deflection (mm)	0.7 / 1.6	1.0 / 1.0	0.3 / 0	0 / 0	0.5 / 1.4	0 / 0.3	0.2 / 0	0.7 / 0.1	1.5 / 1.5	0.5 / 1.0	0.4 / 0.1	0.4 / 0.9	0 / 0	2.2 / 2.0	1.6 / 1.4	0.8 / 0.6
Sounding Test	N-Value per 10 CM Depth from Surface: Carriage Way	150	104	58	58	75	167 / 125	98	136	125	-	250	208	139	91	127	91
Sounding Test	N-Value per 10 CM Depth from Surface: Shoulder	36	25	17	29	30	12	23	125	29	28	-	-	-	-	78	45

Test Result (10)

Field CBR Test







Test Result (11)

Benkelman Beam Test

The 6.0 ton TOYOTA truck fully loaded with laterite soil which was checked to be 5.2 ton per wheel and 6.0 kg/cm^2 air pressure of tire was used as the test load.

The deflection test were tried at two points in one test point. Only six (6) test result are drawn in the following graphs.

A : Max deflection

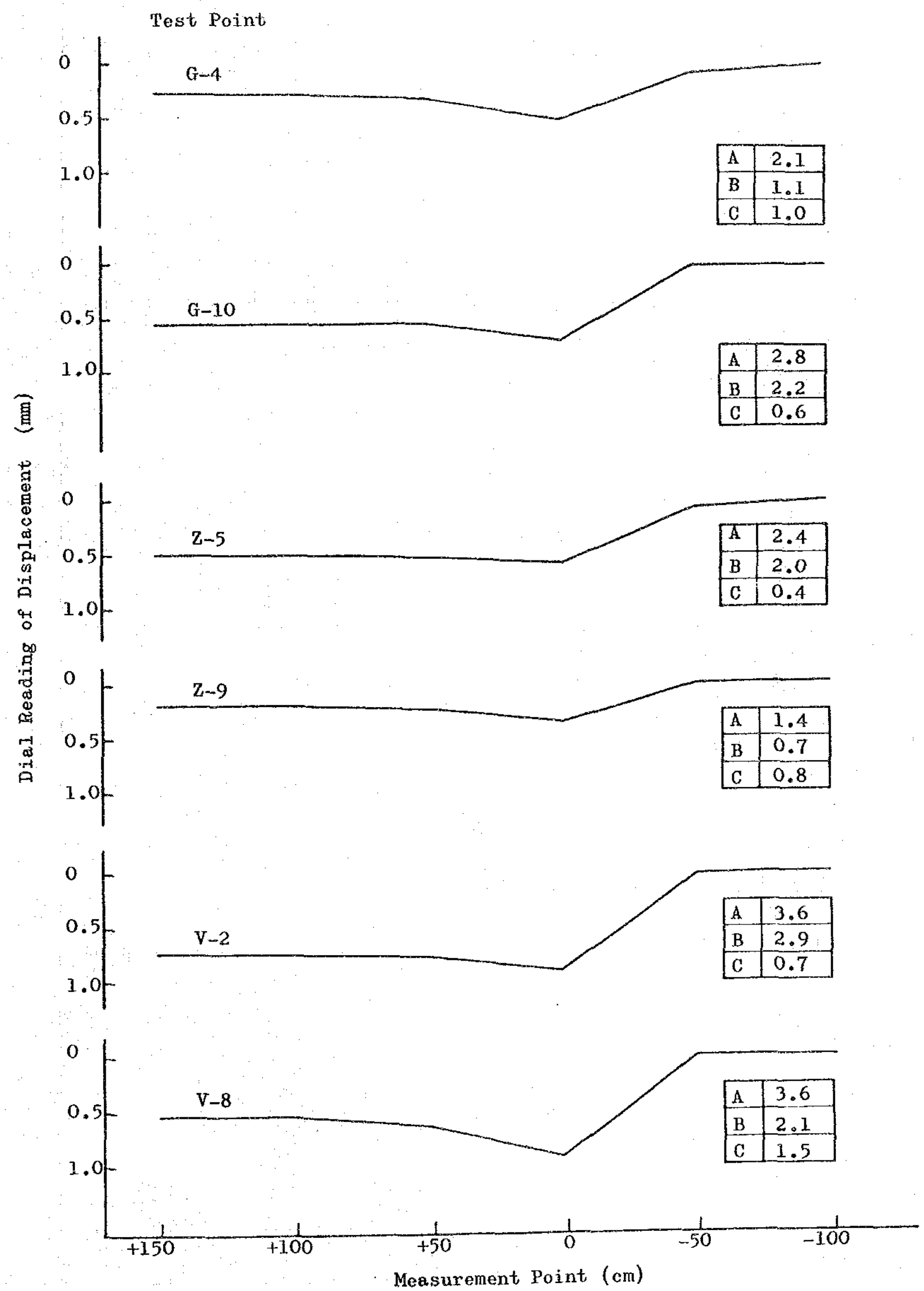
= Initial Dial Reading x 2

B : Final deflection

= Final Dial Reading x 2

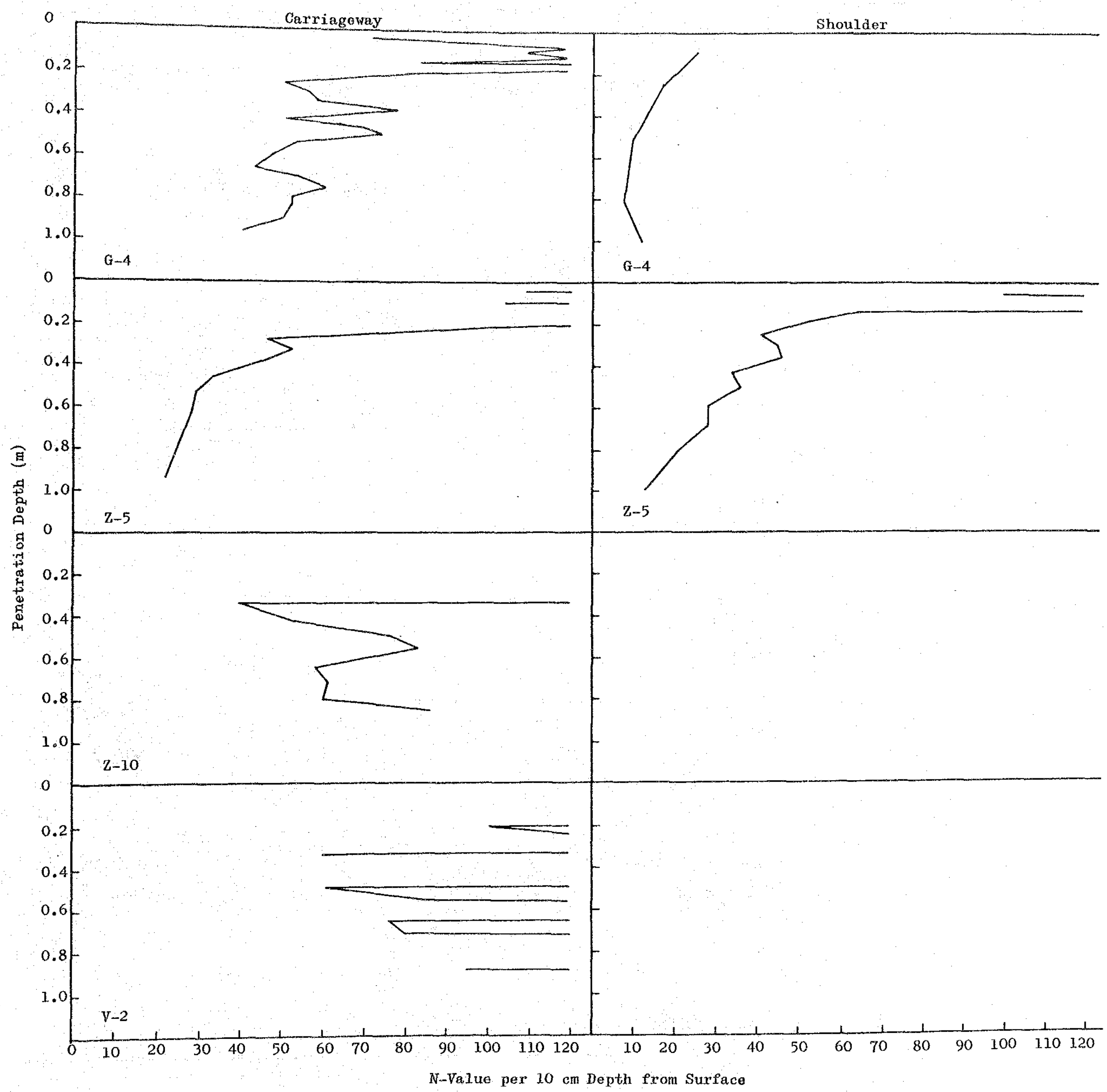
C : Total Rebound Deflection

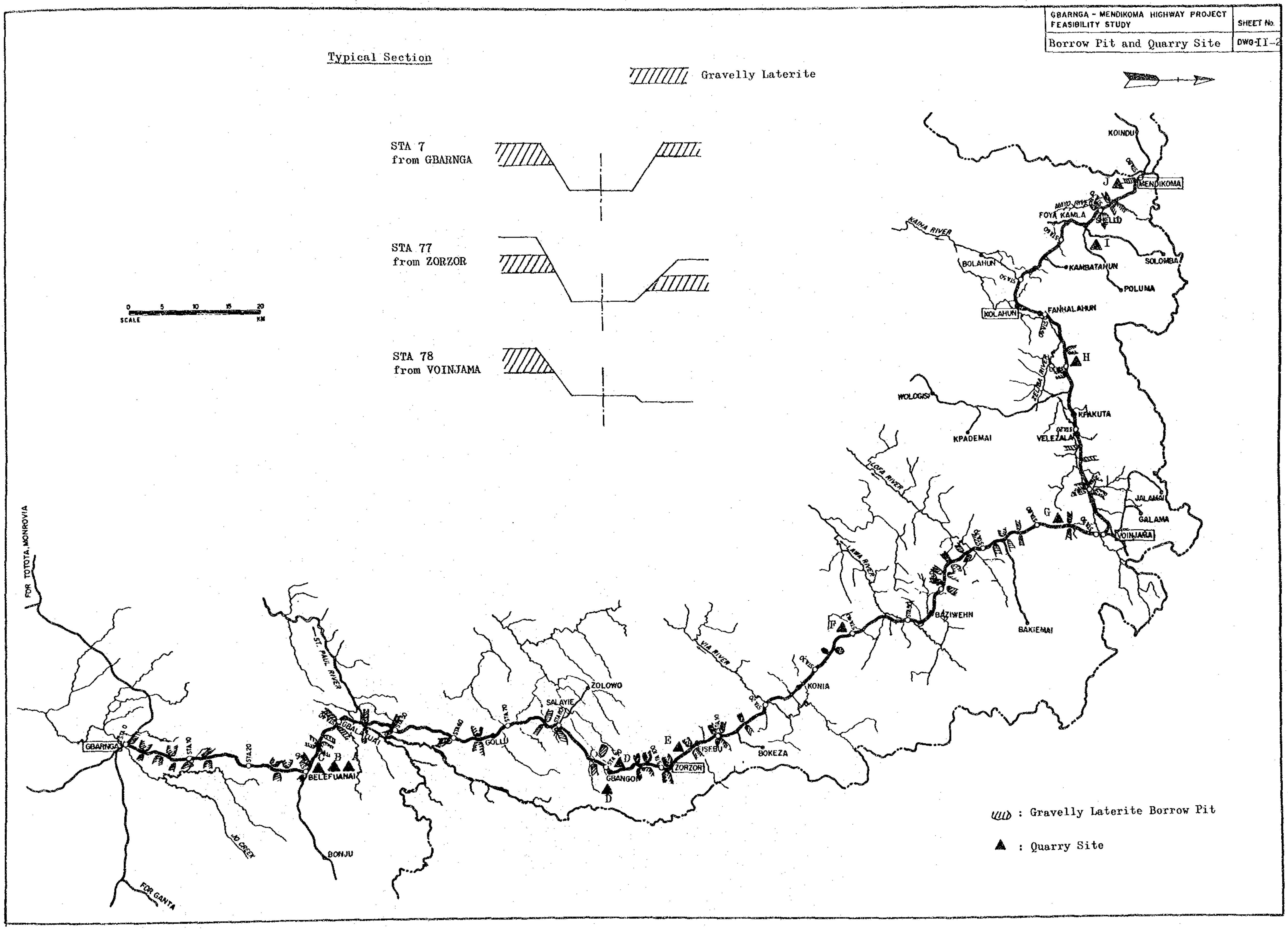
= A - B



Test Result (12)

Sounding Test




GBARNGA - MENDIKOMA HIGHWAY PROJECT
FEASIBILITY STUDY
SHEET No.
Borrow Pit and Quarry Site
DWG·II-2
Typical Section
Gravelly Laterite
STA 7
from GBARNGA
STA 77
from ZORZOR
STA 78
from VOINJAMA
0 5 10 15 20
SCALE
KM
FOR TOTOTA, MONROVIA
FOR GANTA
GBARNGA
BELEFUANAI
GBALATUAI
BONJU
JO CREEK
ST. PAUL RIVER
GOLLU
SALAYIE
ZOLOWO
GBANGOI
ZORZOR
FISEBU
BOKEZA
VIA RIVER
KONIA
BAZIWEHN
BAKIEMAI
LAWA RIVER
LOFA RIVER
VOINJAMA
GALAMA
JALAMAI
KPADEMAI
VELEZALA
KPAKUTA
WOLOGISI
ZELEDA RIVER
KOLAHUN
FANHALAHUN
BOLAHUN
KAIHA RIVER
KAMBATAHUN
POLUMA
SOLOMBA
FOYA KAMLA
SHELLO
MAYO RIVER
MENDIKOMA
KOINDU
A
B
C
D
E
F
G
H
I
J
: Gravelly Laterite Borrow Pit
: Quarry Site

〔III〕

HYDROLOGIC STUDY OF DRAINAGE STRUCTURES

III. HYDROLOGICAL STUDY OF DRAINAGE STRUCTURES

3.1 Formula for Analysis

For the selection of the analysis method for hydrological analysis applicable to the Project area, various formulas were reviewed comparatively and the following was applied.

Rainfall intensity for frequency of 100 years, 50 years, 25 years, and 10 years is calculated using the formula stated below.

100 years ..... $ht\ 100 = 33\ t^{0.4}$

50 years ..... $ht\ 50 = 22\ t^{0.54}$

25 years ..... $ht\ 25 = 19\ t^{0.6}$

10 years ..... $ht\ 10 = 17\ t^{0.58}$

where, ht : rainfall intensity mm/h

t : duration of design rainfall or $t = (t'+1)^{-0.2}t'$ hours

t' : concentration time (hours)

These formulas were selected after comparison of the monthly rainfall records of the Project area and that of GANTA-TAPITA area which are shown in FIG. III-1.

Judging from the expected function of drainage structures, the rainfall intencity of 100 years was applied to calculate river discharges for bridge, the intencity of 50 years and 25 years for calculation of box culvert and pipe culvert, respectively, and the rainfall intencity of 10 years was only calculated as the reference data.

The formula for calculation of discharge is given below:

$$Q = \frac{0.28\ ht \times C \times A \times f}{t} \quad (m^3/sec)$$

where, Q : discharge (m^3/sec)

C : runoff coefficient (0.5)

A : basin area (km^2)

f : coefficient of shape of the hydrograph (0.6)

However, for large rivers such as St. Paul River, Weaher River, Lowa River and Lofa River the following Dicken's formula was applied.

$$Q = C \cdot \sqrt[4]{A^3} \quad (m^3/sec)$$

where, C : coefficient of runoff in hilly area (3.46)

A : basin area (km^2)

On the other hand, for the calculation of the existing drainage capacity the following Manning's formula was used.

$$Q = V \cdot A = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot I^{\frac{1}{2}} \cdot A$$

where, Q : capacity of drainage structure (m^3/sec)

V : velocity (m/sec)

A : drainage section (m^2)

R : Hydrological mean radius (m)

n : roughness coefficient of structure wall

I : slope of drainage structure (%)

3.2 Hydrological Analysis of the Existing Structure

Hydrological analysis of the existing bridges, box-culverts and pipe culverts are made by comparing the drainages capacities and the expected discharges.

3.2.1 Analysis of Catchment Area

The catchment area for each river basin was calculated on the basis of the topographical map (scale 1:250,000) and hydraulic map available from the Land & Minning Ministry. Only, the catchment area of St. Paul River was calculated on the topographical map (scale 1:200,000) gained from the Republic of Guinea.

The summary of calculation and analysis is shown in DWG-III-1 CATCHMENT AREA.

3.2.2 Hydrological Study on Existing Drainage

1) Bridges

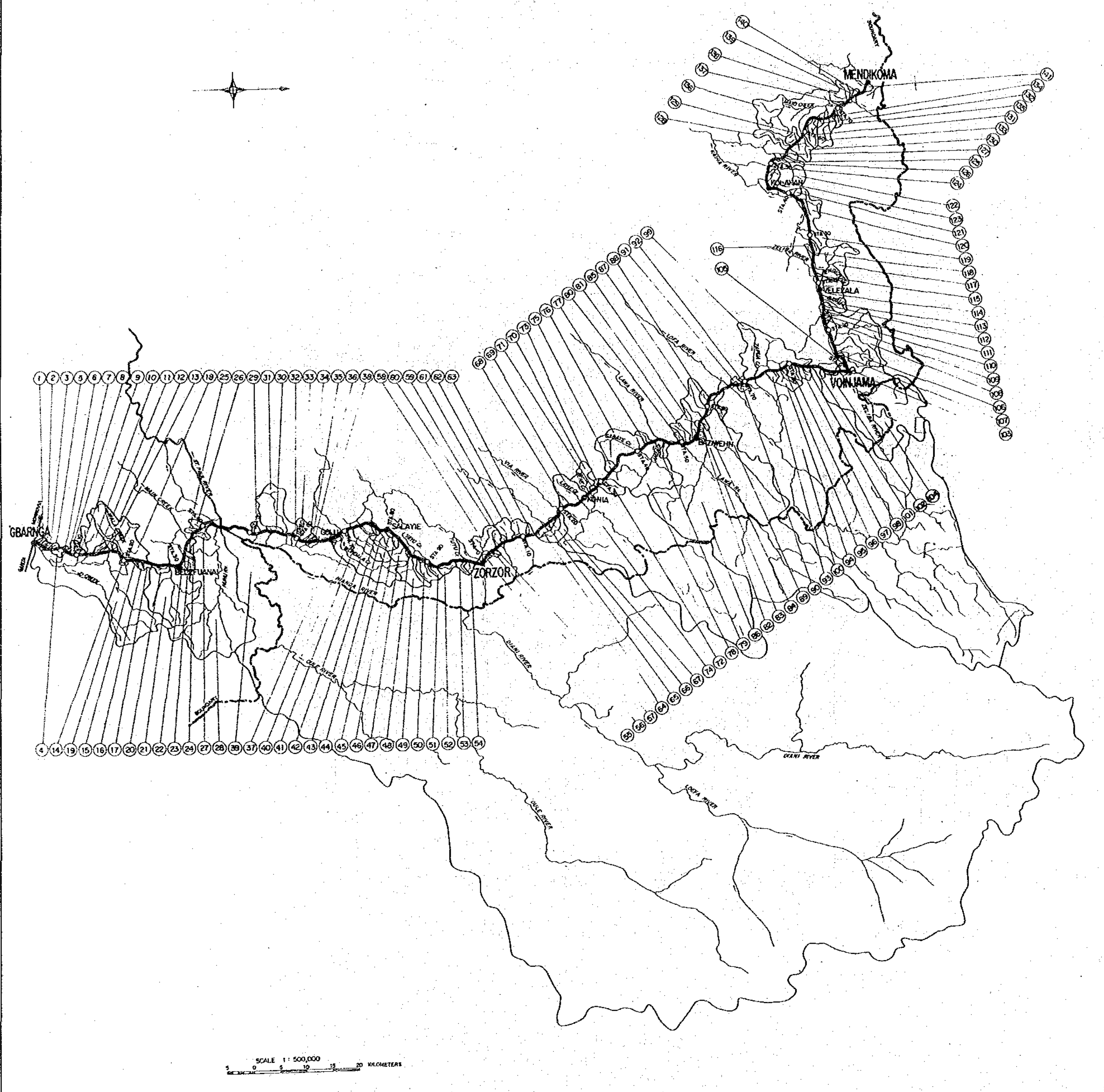
All bridges of the Project road were analyzed and found to be safe for the flood of 100 years rainfall intencity. The result of the hydrologic study on the existing bridges are shown in Table III-1.

The bridges on the rivers, the highest water level of which are near to the discharge capacity are presented in Analysis Result (1)-(5).

2) Box and Pipe Culverts

Other drainage structures are also analyzed and the results are shown in Table III-2～III-4, some capacities of which were found not enough.

GBARNGA - MENDIKOMA HIGHWAY PROJECT FEASIBILITY STUDY	SHEET No.
CATCHMENT AREA	DWG - III - 1



Catching Basin No.	Catchment Area (Km²)	Discharge Q (m³/s) Q_{10}	Q_{25}	Q_{50}	Q_{100}	Remarks	Catching Basin No.	Catchment Area (Km²)	Discharge Q (m³/s) Q_{10}	Q_{25}	Q_{50}	Q_{100}	Remarks
1	1.6	3.3	3.6	4.4	7.7		73	12.2	17.4	19.3	22.8	35.5	
2	0.6	1.4	1.6	1.9	3.5		74	591.5	—	—	—	415.0	Via River
3	0.9	2.1	2.3	2.9	5.2		75	3.6	6.3	7.0	8.5	14.0	
4	2.5	4.9	5.4	6.6	11.2		76	34.0	33.5	37.7	42.8	60.7	
5	2.2	4.0	4.4	5.4	9.0		77	3.7	5.6	6.2	7.4	11.7	
6	1.2	2.7	3.0	3.8	6.7		78	126.3	53.0	90.1	97.2	124.1	Lawa River
7	1.0	2.4	2.6	3.2	5.8		79	3.9	5.9	6.5	7.8	12.3	″
8	2.6	4.2	4.7	5.6	9.0		80	1.8	3.5	3.9	4.8	8.1	
9	3.0	4.9	5.4	6.4	10.4		81	6.7	7.8	8.8	10.1	15.0	
10	20.0	21.0	23.5	26.8	38.7		82	2.4	4.6	5.0	6.1	10.2	
11	2.8	4.6	5.0	6.0	9.7		83	1.5	3.4	3.6	4.5	8.0	
12	1.5	3.4	3.6	4.5	8.0		84	1.8	3.3	3.6	4.4	7.4	
13	3.7	7.3	8.0	9.8	16.6		85	25.7	17.1	24.9	27.7	38.1	
14	1.0	2.6	2.8	3.5	6.5		86	726.2	—	—	—	484.0	Lawa River
15	1.2	2.7	2.9	3.6	6.4		87	12.0	12.2	13.7	16.0	22.3	
16	1.3	2.6	2.8	3.4	5.8		88	4.3	7.0	7.7	9.2	14.9	
17	2.2	4.9	5.3	6.6	11.8	Main Creek	89	26.3	20.5	23.2	25.6	34.4	Lofa River
18	60.7	45.7	52.0	57.3	76.4	Jo Creek	90	2.7	5.3	5.9	7.1	12.2	
19	315.3	133.2	154.0	160.4	187.5	Main Creek	91	4.9	3.3	3.7	9.7	15.5	
20	3.8	6.2	6.8	6.9	13.2	″	92	1.1	2.6	2.8	3.5	6.4	
21	79.0	64.3	72.8	80.7	109.5	″	93	3.0	5.3	5.8	7.1	11.7	
22	6.2	9.8	10.9	13.0	20.8	″	94	10.0	11.7	13.1	15.1	22.4	
23	2.0	3.7	4.0	4.9	8.2	″	95	1.3	2.7	3.0	3.7	6.4	
24	2.5	4.4	4.9	5.9	9.7	″	96	6.0	8.6	9.5	11.2	17.5	
25	2.5	4.1	4.5	5.4	8.7		97	3.0	4.6	5.0	6.0	9.5	
26	3.8	6.2	6.8	8.2	13.2		98	1.3	2.6	2.8	3.4	5.9	
27	14.3	15.5	17.4	19.9	29.0	Nunu River	99	94.6	46.6	72.0	78.2	101.[illegible]	
28	215.0	122.7	140.7	150.5	188.0	″	100	1610.6	—	—	—	859.7	Lofa River
29	2.5	4.6	5.0	6.1	10.3		101	4.2	6.8	7.5	9.0	14.6	Zeliba River
30	2.2	6.0	6.4	8.2	15.3		102	2.1	4.1	4.6	6.3	9.5	″
31	45.0	40.9	46.2	51.8	72.2		103	1.1	2.6	2.8	3.5	6.4	
32	1.1	2.3	2.5	3.1	5.3		104	193.1	116.8	133.8	144.0	182.5	Zeliba River
33	11.0	15.7	17.4	20.5	32.0		105	0.8	2.1	2.3	2.8	5.2	
34	1.5	2.9	3.3	4.0	6.8		106	27.8	24.8	28.8	32.4	45.2	Zeliba River
35	0.8	2.2	2.3	3.0	5.6		107	1.3	2.9	3.1	3.9	7.0	″
36	0.6	1.7	1.8	2.4	4.5		108	67.0	50.5	57.4	63.2	84.3	″
37	1.5	2.9	3.3	4.0	6.8		109	0.9	2.2	2.4	3.1	5.6	″
38	9.5	10.2	13.5	15.7	28.8		110	0.7	1.9	2.0	2.6	4.9	″
39	8758.5	—	—	—	3132.6	St.Paul River	111	0.8	2.4	2.6	3.3	6.3	″
40	53.0	38.6	44.0	48.1	63.7	Kuddo Creek	112	2.0	3.7	4.0	4.9	8.2	″
41	23.0	20.9	23.6	26.5	36.9	Yawo Creek	113	6.0	7.6	8.5	9.9	15.1	″
42	3.8	7.0	7.7	9.3	15.6	″	114	15.0	17.9	20.0	23.1	34.4	″
43	1.8	4.0	4.4	5.4	9.6	″	115	1.5	3.5	3.9	4.8	8.7	″
44	10.0	13.5	14.9	17.5	26.9	″	116	3.7	5.3	5.9	6.9	10.8	
45	1.0	2.7	2.9	3.7	7.0	″	117	43.7	34.9	39.5	43.7	54.1	Zeliba River
46	2.2	3.9	4.3	5.2	8.6	Yawo Wayo Creek	118	2.4	2.0	2.2	2.5	3.3	″
47	8.0	12.1	13.4	15.9	25.2	″	119	11.0	14.0	15.7	18.2	27.6	″
48	1.2	2.5	2.7	3.3	5.7	″	120	14.0	17.6	19.7	22.7	33.8	″
49	15.0	17.6	19.7	22.6	33.6	″	121	2.6	4.8	5.2	6.4	10.7	″
50	11.0	13.7	15.3	17.7	26.7	″	122	22.0	22.4	25.2	28.5	40.9	″
51	3.3	5.4	5.9	7.1	11.5	″	123	7.0	10.6	11.7	13.9	22.1	″
52	5.3	7.9	8.8	10.4	16.4	″	124	2.1	4.5	5.0	6.1	10.8	″
53	4.0	6.2	6.9	8.2	13.1	″	125	3.1	4.5	5.0	5.9	9.3	″
54	3.2	5.6	6.2	7.5	12.5	″	126	4.5	6.4	7.1	8.3	13.0	″
55	1.3	3.9	4.2	5.4	10.5		127	3.4	6.0	6.6	8.0	13.2	″
56	1.0	2.1	2.3	2.8	4.8		128	8.0	7.7	8.6	9.8	13.7	
57	0.8	1.8	1.9	2.4	4.3		129	5.0	8.1	9.0	10.7	17.4	
58	21.1	17.0	19.2	25.3	35.5		130	23.0	17.3	19.7	21.7	28.9	
59	4.4	6.8	7.5	9.0	14.4		131	11.0	12.9	14.4	16.6	24.7	
60	1.5	3.0	3.3	4.0	6.8		132	1.3	2.9	3.1	3.9	7.0	
61	8.0	10.8	12.0	14.0	21.5		133	11.0	12.9	14.4	16.6	24.7	
62	9.0	12.8	14.2	16.8	26.2		134	0.6	1.3	1.5	1.8	3.2	
63	2.3	4.0	4.5	5.4	9.0		135	2.2	3.3	3.7	4.4	6.9	
64	2.6	4.6	5.1	6.1	10.1	Nowi River	136	140.1	70.2	80.9	85.5	104.0	Moyo River
65	0.6	1.4	1.5	1.9	3.5	″	137	1.3	2.3	2.5	3.1	5.1	″
66	1.1	3.0	3.2	4.1	7.7		138	8.0	10.8	12.0	14.0	21.5	″
67	16.0	16.8	18.8	21.5	30.9	Washe River	139	2.3	4.2	4.6	5.6	9.4	″
68	3.3	5.4	5.9	7.1	11.5		140	0.8	2.0	2.2	2.7	5.0	″
69	24.0	25.2	28.2	32.2	46.4		141	1.3	3.1	3.3	4.2	7.6	″
70	16.0	17.4	19.5	22.3	32.5								
71	1.0	2.7	2.9	3.7	7.0								
72	10.5	13.4	14.9	17.3	26.3								

Fig. III-1 (1963-1972) Monthly Rainfall Record

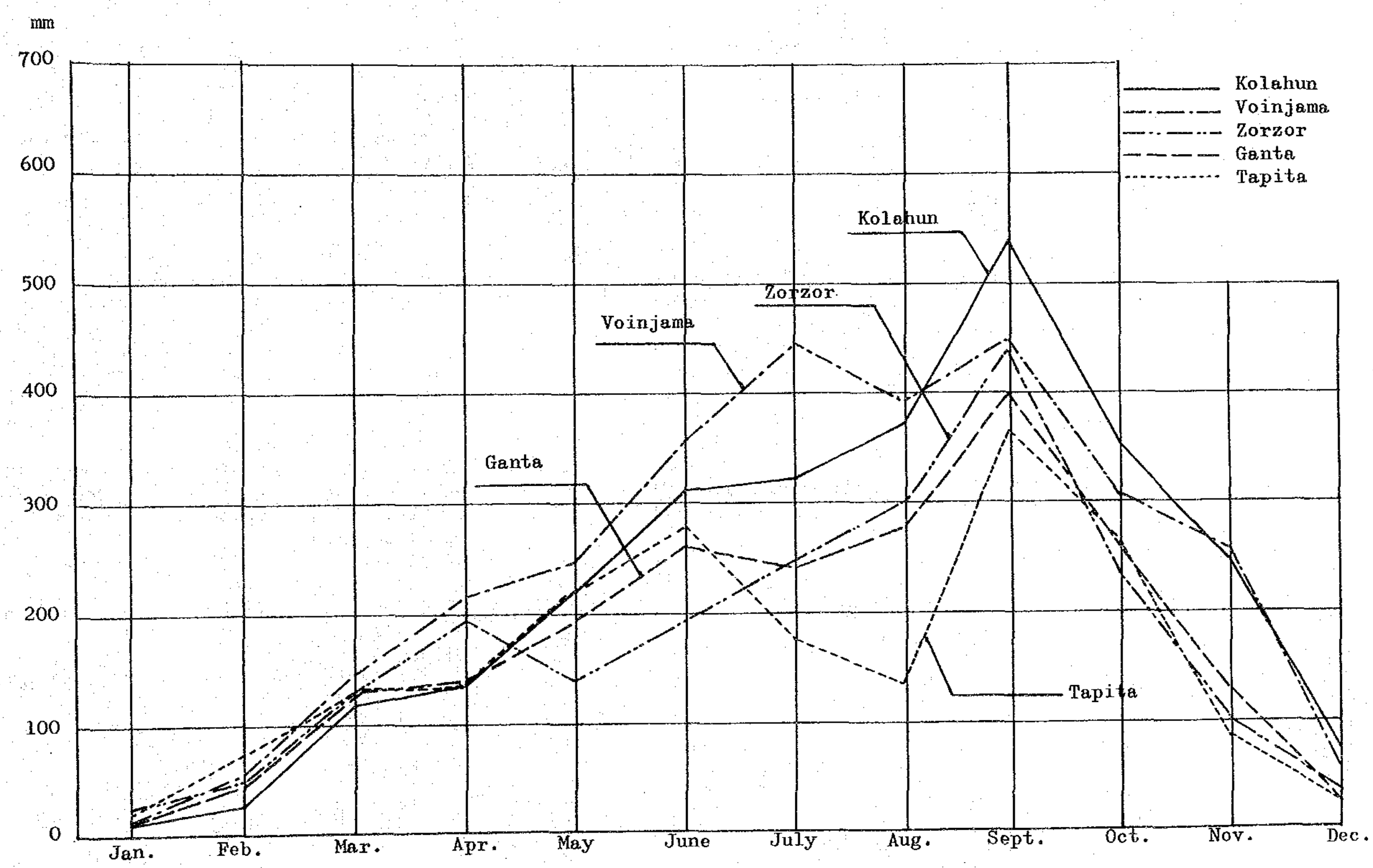


Table III-1 Bridge Inventory and Hydrological Study

Bridge No.	Accum. Dist. (mile)	(km)	River Name	Br. Length (m)	Span Composition (m)	Effective Width (m)	Type of Br.	Condition	Capacity (m^3/s)	Discharge (m^3/s)	Catching Basin No.	Remarks
GBARNGA	0	0										
1	17.9	28.7	Mem Creek	15.15	14.75	6.90	Steel Girder	Good	123.2	109.5	21	See Hydrograph
2	26.7	42.9	Noom River	18.20	17.80	7.50	Concrete T-Beam	"	197.9	188.0	28	- do -
3	27.6	44.4	St. Paul River	123.45	14.80+12.20 +15.25+49.60	7.40	Concrete T-Beam (5) Steel Truss (1)	"	3543.2	3132.6	39	- do -
4	37.7	60.6		9.85	9.45	7.40	Concrete Slab	"	59.9	32.0	33	
5	39.8	64.0	Leya River	9.85	9.45	7.40	"	"	59.9	28.8	38	
6	43.4	69.2		18.60	18.20	7.43	Concrete T-Beam	"	224.4	63.7	40	
7	44.6	71.8		15.60	15.20	7.43	"	"	124.2	36.9	41	
8	48.3	77.7	Sepayea River	15.60	15.20	7.45	"	"	172.8	26.9	44	
9	54.6	87.9		9.60	9.20	7.40	Concrete Slab	"	34.0	33.6	49	- do -
10	55.1	88.7		9.95	9.55	7.25	"	"	48.9	26.7	50	
11	63.2	101.7		10.25	9.85	7.45	"	"	63.2	12.5	54	
ZORZOR	0	0										
1	0.5	0.8		16.30	15.90	7.70	Concrete T-Beam	Good	119.1	35.5	58	
2	11.5	18.6	Weaher River	10.50	10.00	7.45	Concrete Slab	"	65.0	30.9	67	
3	12.5	20.1	Via River	47.60	10.10+18.15 +18.15	"	" (1) Concrete T-Beam (2)	"	1240.2	415.0	74	- do -
4	14.1	22.7		9.50	9.10	"	Concrete Slab	"	71.3	11.5	68	
5	15.3	24.6	Layie Creek	15.70	15.30	"	Concrete T-Beam	"	95.1	46.4	69	
6	17.0	27.3	Bene Creek	10.40	10.00	"	Concrete Slab	"	64.0	32.5	70	
7	17.9	28.8		16.50	16.10	"	Concrete T-Beam	"	112.0	35.5	73	
8	25.7	41.4	Gabaryca River	31.25	15.30+15.15	7.40	"	"	460.6	60.7	76	
9	28.6	46.0	Lueah River	49.95	24.65+24.50	"	Concrete Box girder	"	1011.4	124.1	78	
10	30.8	49.5	Lawa River	68.40	14.80+19.20 +18.00+14.80	"	Concrete T-Beam	"	1175.3	484.0	86	- do -
11	33.1	53.3	Zear River	49.10	17.40+18.30 +12.20	"	"	"	983.2	38.1	85	
12	42.3	68.0	Lofa River	93.20	30.40+30.75 +30.85	7.45	Concrete Box girder	"	2939.3	879.7	100	- do -
13	45.3	72.9		31.45	12.10+18.55	7.40	Concrete T-Beam	"	769.1	101.1	99	
14	56.5	90.9	Zeliba River	37.60	18.30+18.50	"	"	"	484.9	182.5	104	
VOINJAMA	0	0										
1	4.8	7.7		15.75		7.45	Concrete T-Beam	Good	105.4	84.3	108	- do -
2	23.6	38.0		18.90	18.90	"	"	"	163.3	33.8	120	
3	26.8	43.2		12.60		"	"	"	82.6	40.9	122	- do -
4	43.6	70.1	Maiyo River	43.85	12.75+18.45 +12.65	"	"	"	244.7	104.0	136	- do -

Table III-2 Discharge Calculation (1)

No.	Catchment Area (km²)	Discharge Q (m³/sec)	Existing Drainage Structures Dimension (m)	Capa-city (m³/sec)	Remarks
1	1.6	3.60	P(cor) ø1.00 P(cor) ø1.10	2.9	Out
2	0.6	1.54	P(cor) ø1.35	2.8	
3	0.9	2.30	P(cor) ø1.20	2.2	
4	2.5	6.60	C-Bx 2-3.00 x 1.50	28.0	
5	2.2	5.37	C-Bx 2.90 x 3.00	32.4	
6	1.2	3.01	P(cor) ø1.25 P(cor) ø1.00	3.6	
7	1.0	2.57	P(cor) ø1.40 P(cor) ø1.00	4.4	
8	2.6	4.66	P(cor) ø1.20	2.2	Out
9	3.0	6.44	C-Bx 2-2.45 x 1.60	23.3	
10	20.0	26.82	C-Bx 2-3.50 x 3.50	102.4	
11	2.8	6.01	C-Bx 3.10 x 2.20	24.1	
12	1.5	3.62	P(cor) ø1.40	3.1	
13	3.7	9.76	C-Bx 3.10 x 2.20	24.1	
14	1.0	2.82	P(cor) ø1.45 P(cor) ø0.80	4.5	
15	1.2	2.90	P(cor) ø1.05 ø0.70 ø1.40	5.1	
16	1.3	2.81	P(cor) 2-ø0.60 ø1.60	5.8	
17	2.2	5.31	P(cor) ø0.60 ø1.40	3.7	Out
18	60.7	57.27	C-Bx 3.00 x 3.00	33.9	Out
19	315.3	187.46	Br 7.25 x 9.85	197.9	
20	3.8	6.80	P(cor) ø0.80	0.8	Out
21	79.0	109.54	Br 6.90 x 15.15	123.2	
22	6.2	12.96	C-Bx 2-3.00 x 3.00	67.8	
23	2.0	4.03	P(cor) 2-ø1.40	6.2	
24	2.5	4.87	P(cor) ø0.60 ø1.50	4.5	
25	2.5	4.48	P(cor) ø1.60	9.1	

No.	Catchment Area (km²)	Discharge Q (m³/sec)	Existing Drainage Structures Dimension (m)	Capa-city (m³/sec)	Remarks
26	3.8	8.16	C-Bx 3.50 x 3.05	38.9	
27	14.3	19.93	C-Bx 2-6.5 x 3.05	202.4	
28	215.0	187.98	Br 7.50 x 18.20	197.9	
29	2.5	6.11	C-Bx 3.50 x 3.10	44.1	
30	2.2	6.41	P(cor) ø0.80 4 - ø1.20	9.4	
31	45.0	51.83	P(cor) 2 - ø1.50	7.6	
32	1.1	2.47	P(cor) ø0.90 ø1.60	5.7	
33	11.0	31.99	Br 7.40 x 9.85	59.9	
34	1.5	3.25	P(cor) 2-ø1.00	2.6	
35	0.8	2.33	P(cor) ø0.60	0.6	
36	0.6	1.84	P(cor) 2-ø0.85	1.8	
37	1.5	3.96	C-Bx 3.00 x 2.50	27.1	
38	9.5	28.83	Br 7.40 x 9.85	59.9	
39	8,758.5	3,132.55	Br 7.40 x 123.45	3,543.2	
40	53.0	63.72	Br 7.43 x 18.60	224.4	
41	23.0	36.89	Br 7.43 x 15.60	124.2	
42	3.8	9.28	C-Bx 2-3.10 x 3.00	71.1	
43	1.8	4.35	P(cor) 4-ø1.20	9.0	
44	10.0	26.90	Br 7.45 x 15.60	172.8	
45	1.0	2.91	P(cor) 3-ø1.40	9.4	
46	2.2	4.28	P(cor) 3-ø1.60	13.7	
47	8.0	15.89	C-Bx 2-6.40 x 18.20	193.8	
48	1.2	2.70	P(cor) 2-ø1.50	7.6	
49	15.0	33.62	Br 7.40 x 9.60	34.0	
50	11.0	26.70	Br 7.25 x 9.95	48.9	

TABLE III-3 Discharge Calculation (2)

No.	Catchment Area (km^2)	Discharge Q (m^3/sec)	Existing Drainage Structures Dimension (m)	Capa-city (m^3/sec)	Remarks
51	3.3	5.92	P(cor) ø0.80	0.8	
52	5.3	10.41	C-Bx 2-6.40 x 3.00	193.8	
53	4.0	6.86	P(cor) ø1.80	6.2	
54	3.2	12.46	Br 7.45 x 10.25	63.2	
55	1.3	4.20	P(cor) 2-ø1.20	4.5	
56	1.0	2.25	P(cor) 2-ø1.20 ø0.90	3.3	
57	0.8	1.93	P(cor) ø0.85 2-ø0.80	2.4	
58	21.1	35.51	Br 7.70 x 16.30	119.1	
59	4.4	8.96	C-Bx 3.10 x 3.10	37.1	
60	1.5	3.25	P(cor) ø0.60 2-ø1.20	5.1	
61	8.0	11.95	P(cor) 2-ø1.60	9.1	Out
62	9.0	14.24	P(cor) 5-ø1.60	22.8	
63	2.3	4.48	P(cor) 2-ø1.60	4.5	
64	2.6	5.06	P(cor) 2-ø1.60 2-ø1.20	13.6	
65	0.6	1.54	P(cor) ø0.70 ø1.00	1.9	
66	1.1	3.21	P(cor) 3-ø1.20	6.7	
67	16.0	30.93	Br 7.45 x 10.50	65.0	
68	3.3	11.45	Br 7.45 x 9.50	71.3	
69	24.0	46.40	Br 7.45 x 15.70	95.1	
70	16.0	32.49	Br 7.45 x 10.40	64.0	
71	1.0	2.91	P(cor) ø0.80	0.8	Out
72	10.5	14.94	P(cor) ø1.20	2.2	Out
73	12.2	35.48	Br 7.45 x 16.50	112.0	
74	591.5	414.99	Br 7.45 x 47.60	1,240.2	
75	3.6	8.48	C-Bx 3.10 x 3.00	35.6	
76	34.0	60.68	Br 7.40 x 31.25	460.6	
77	3.7	6.19	P(cor) ø1.40 ø0.60	3.8	Out
78	126.3	124.14	Br 7.40 x 49.95	1,011.4	
79	3.9	6.52	P(cor) 2-ø1.60	9.1	
80	1.8	3.90	P(cor) ø1.20 ø1.00	3.5	
81	6.7	10.10	C-Bx 2-3.00 x 3.00	67.8	
82	2.4	4.98	P(cor) 2-ø1.20	4.5	
83	1.5	3.62	P(cor) 2-ø1.50	7.6	
84	1.8	3.60	P(cor) ø1.60	4.6	
85	25.7	38.08	Br 7.40 x 49.10	983.2	
86	726.2	484.03	Br 7.40 x 68.40	1,175.3	
87	12.0	13.73	P(cor) ø1.20 2-ø1.25	6.9	Out
88	4.3	7.71	P(cor) ø1.20	2.3	Out
89	26.3	23.17	P(cor) 4-ø1.20	9.0	Out
90	2.7	5.85	P(cor) ø0.80	0.8	Out
91	4.9	3.68	P(cor) ø1.15	1.8	Out
92	1.1	2.82	P(cor) 2-ø1.40	6.2	
93	3.0	5.84	P(cor) ø1.20 2-ø0.80 ø1.00	4.8	Out
94	10.0	13.11	P(cor) ø0.80 ø1.20	3.0	Out
95	1.3	2.98	P(cor) ø0.90	1.0	Out
96	6.0	11.20	C-Bx 2-3.00 x 3.00	67.8	
97	3.0	5.02	P(cor) 2-ø0.90 2-ø1.20	2.1	Out
98	1.3	2.82	5-ø1.60	27.3	
99	94.6	101.11	Br 7.40 x 31.45	769.1	
100	1,610.6	879.66	Br 7.45 x 93.20	2,939.3	

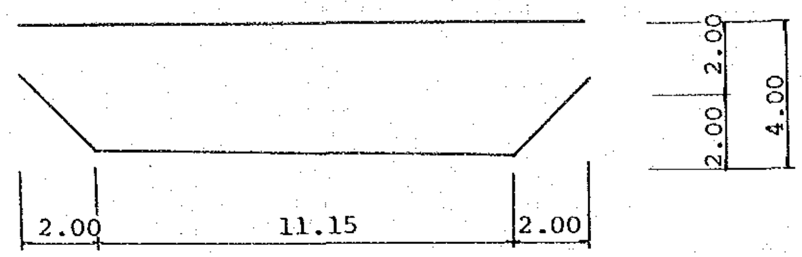
TABLE III-4 Discharge Calculation (3)

No.	Catchment Area (km^2)	Discharge Q (m^3/sec)	Existing Drainage Structures		Remarks
			Dimension (m)	Capa-city (m^3/sec)	
101	4.2	7.53	P(cor) 2-ø1.60	9.1	
102	2.1	4.55	P(cor) 2-ø1.50 2-ø1.40	13.9	
103	1.1	2.82	P(cor) 3-ø1.20 ø0.60	7.3	
104	193.1	182.46	Br 7.40 x 37.60	484.9	
105	0.8	2.26	P(cor) 2-ø1.60	9.1	
106	27.8	32.35	C-Bx 2-3.00 x 3.00	67.8	
107	1.3	3.14	P(cor) 2-ø1.60	9.1	
108	67.0	84.28	Br 7.45 x 15.75	105.4	
109	0.9	3.06	C-Bx 3.00 x 3.00	33.9	
110	0.7	2.04	P(cor) 3-ø1.40	9.1	
111	0.8	2.58	P(cor) 4-ø1.40	12.2	
112	2.0	4.00	P(cor) ø1.40	3.0	Out
113	6.0	9.91	C-Bx 2-3.00 x 3.00	67.8	
114	15.0	23.07	C-Bx 2-3.00 x 3.00	67.8	
115	1.5	3.85	P(cor) 2-ø1.60 ø1.00	10.5	
116	3.7	6.91	C-Bx 3.00 x 3.00	33.9	
117	43.7	43.73	C-Bx 2-3.00 x 3.00	67.8	
118	2.4	2.21	P(cor) ø1.60 ø1.20	6.7	
119	11.0	18.16	C-Bx 2-3.00 x 3.00	67.8	
120	14.0	33.83	Br 7.45 x 18.9	163.3	
121	2.6	5.24	P(cor) 2-ø1.60	9.1	
122	22.0	40.85	Br 7.45 x 12.60	82.6	
123	7.0	13.91	C-Bx 3.00 x 3.00	33.9	
124	2.1	4.96	P(cor) 2-ø1.20 2-ø0.80	6.1	
125	3.1	5.90	C-Bx 3.00 x 3.00	33.9	
126	4.5	8.31	C-Bx 3.00 x 2.00	20.4	
127	3.4	8.01	C-Bx 3.00 x 3.00	33.9	
128	8.0	9.75	C-Bx 3.00 x 2.50	27.1	
129	5.0	10.73	C-Bx 3.00 x 3.00	33.9	
130	23.0	21.70	C-Bx 2-3.00 x 3.00	67.8	
131	11.0	16.58	C-Bx 2-2.50 x 2.00	31.2	
132	1.3	3.14	P(cor) ø1.20	2.2	Out
133	11.0	16.58	C-Bx 2-2.30 x 1.80	24.6	
134	0.6	1.45	P(cor) ø1.50	3.8	
135	2.2	3.68	P(cor) ø0.80	0.8	Out
136	140.1	103.95	Br 7.45 x 43.85	244.7	
137	1.3	2.53	P(cor) ø1.20	2.2	
138	8.0	13.98	C-Bx 2-2.40 x 1.80	26.2	
139	2.3	4.60	P(cor) 2-ø0.7	1.3	Out
140	0.8	2.17	P(cor) ø0.75 ø0.60	1.3	
141	1.3	3.33	P(cor) ø1.60	4.6	

GBARNGA - ZORZOR

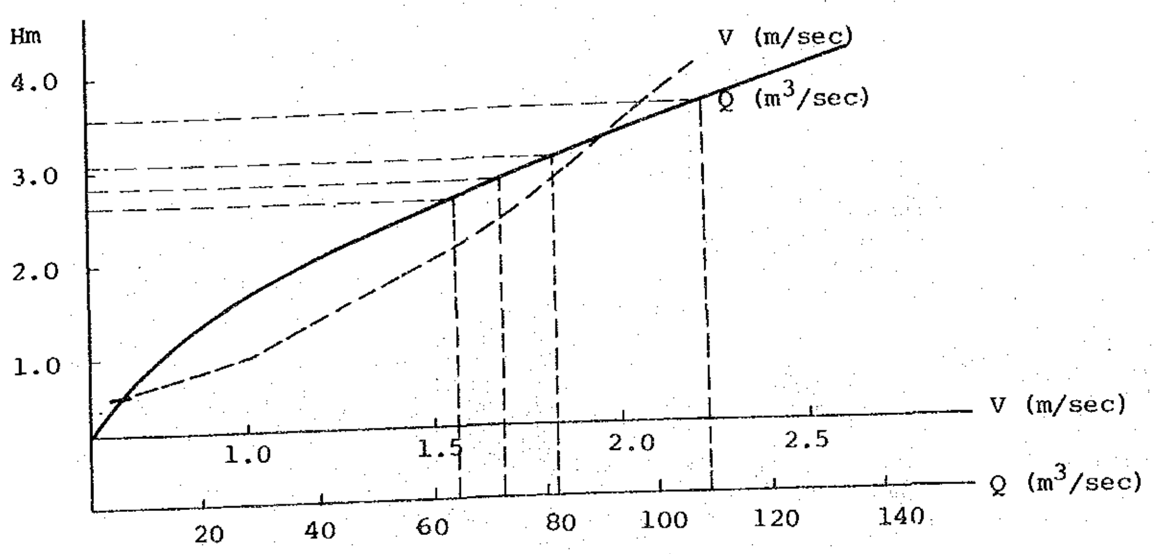
BRIDGE NO.1 (Mem Creek)

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 18.6km



Q=109.54 m^3/sec   i=0.002
n=0.04

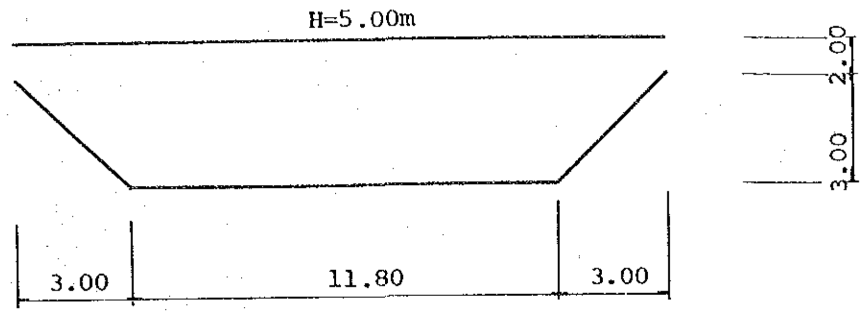
H (m)	A (m^2)	P (m)	R (m)	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	5.85	12.56	0.462	0.598	0.0447	0.668	3.91
1.00	12.15	13.98	0.869	0.911	"	1.018	12.37
1.50	18.98	15.39	1.233	1.150	"	1.285	24.39
2.00	26.30	16.81	1.565	1.348	"	1.506	39.62
2.50	33.88	17.81	1.902	1.535	"	1.715	58.12
3.00	41.46	18.81	2.204	1.694	"	1.893	78.49
3.50	49.03	19.81	2.475	1.830	"	2.045	100.27
4.00	56.60	20.81	2.720	1.948	"	2.177	123.24



GBARNGA - ZORZOR

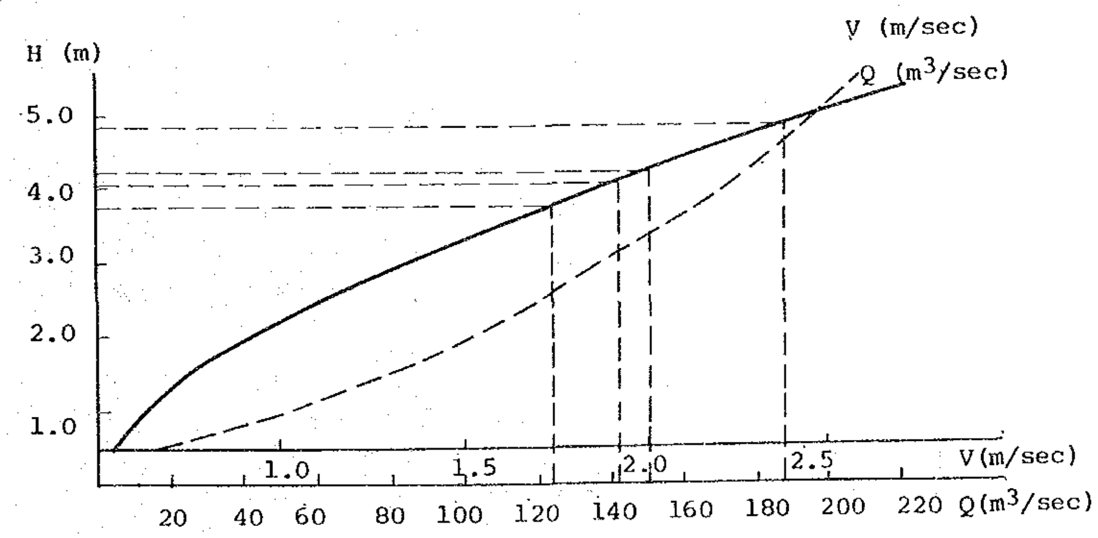
BRIDGE NO.2 (Noorn River)

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 42.9km



Q=1880 m^3/sec   i=0.002
n=0.04

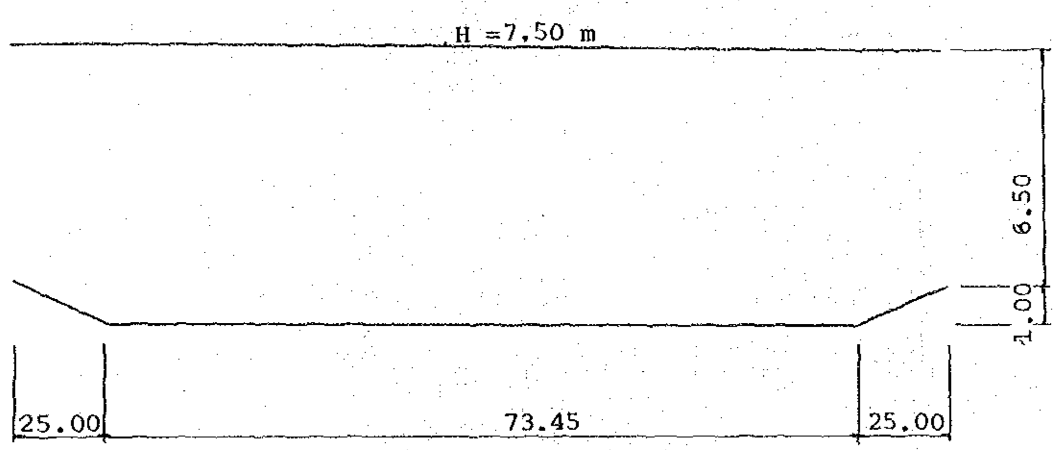
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	6.15	13.21	0.466	0.601	0.0447	0.672	4.13
1.00	12.80	14.63	0.875	0.915	"	1.023	13.09
1.50	19.95	16.04	1.244	1.157	"	1.293	25.80
2.00	27.60	17.46	1.581	1.357	"	1.516	41.84
2.50	35.75	18.87	1.895	1.531	"	1.711	61.17
3.00	44.40	20.29	2.188	1.686	"	1.884	83.65
3.50	53.30	21.29	2.504	1.844	"	2.060	109.82
4.00	62.20	22.29	2.790	1.982	"	2.215	137.77
4.50	71.10	23.29	3.053	2.105	"	2.352	167.21
5.00	80.00	24.29	3.294	2.214	"	2.474	197.90
5.50	88.90	25.29	3.515	2.312	"	2.584	229.72



GBARNGA - ZORZOR

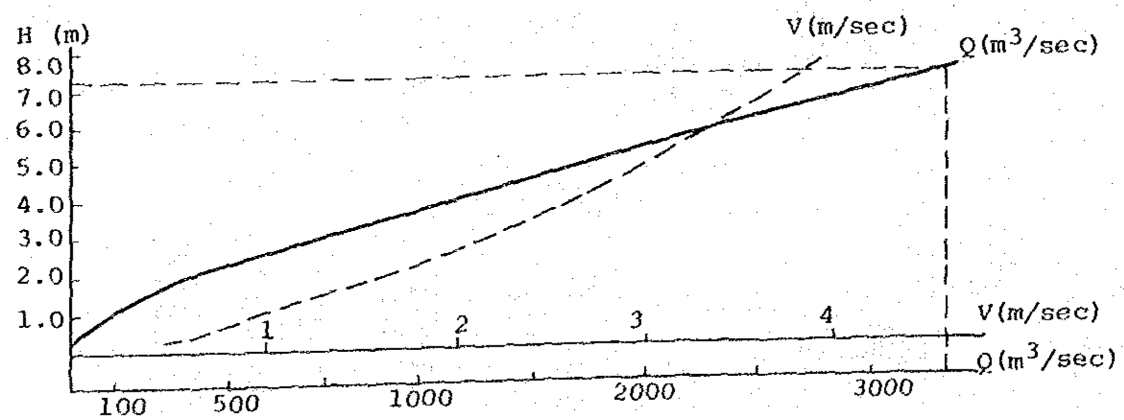
BRIDGE NO.3 (St. Paul River)

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 44.4km



Q =3,132.6 m³/sec i = 0.002 n = 0.04

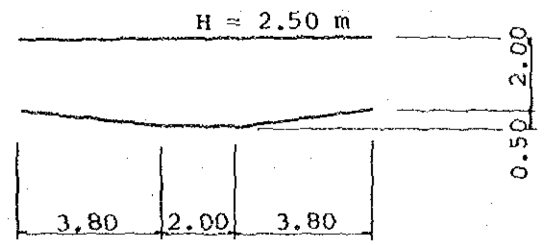
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	43.98	98.45	0.447	0.584	0.0447	0.653	28.72
1.00	98.45	123.45	0.797	0.860	"	0.961	94.62
1.50	160.18	124.45	1.287	1.183	"	1.322	211.76
2.00	221.90	125.45	1.769	1.463	"	1.635	362.78
3.00	345.36	127.45	2.710	1.944	"	2.172	750.27
4.00	468.81	129.45	3.622	2.358	"	2.635	1235.34
5.00	592.26	131.45	4.506	2.728	"	3.049	1805.53
6.00	715.71	133.45	5.363	3.064	"	3.424	2450.61
7.00	839.16	135.45	6.195	3.373	"	3.769	3163.07
7.50	900.89	136.45	6.602	3.519	"	3.933	3543.20



GBARNGA - ZORZOR

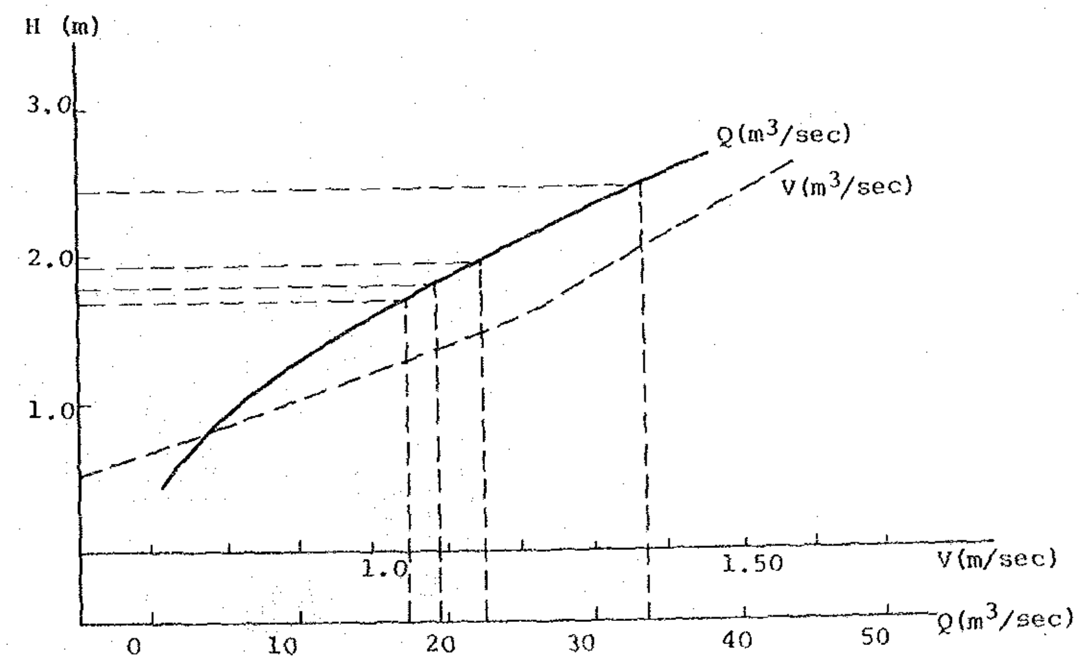
BRIDGE NO.9

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 87.9km



Q = 33.62 m³/sec i = 0.002 n = 0.04

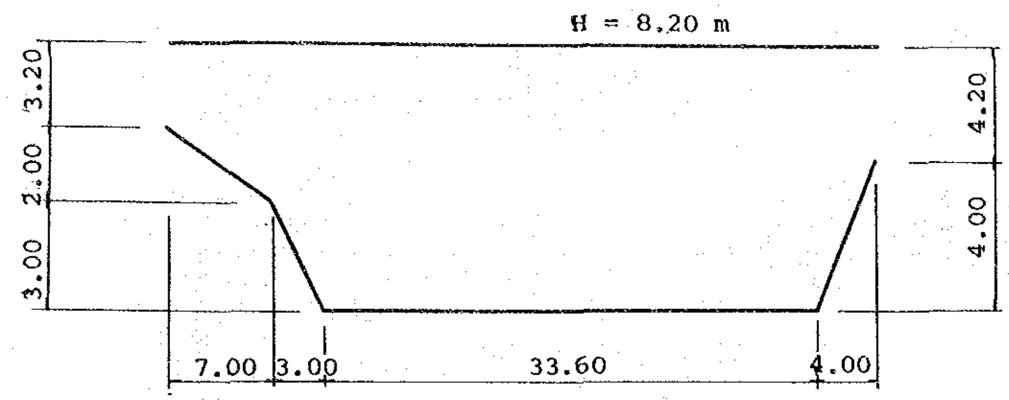
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	2.90	9.666	0.300	0.448	0.0447	0.501	1.45
1.00	7.70	10.666	0.722	0.805	"	0.899	6.92
1.50	12.50	11.666	1.071	1.047	"	1.170	14.62
2.00	17.30	12.666	1.366	1.231	"	1.376	23.80
2.50	22.10	13.666	1.617	1.378	"	1.540	34.03



ZORZOR - VOINJAMA

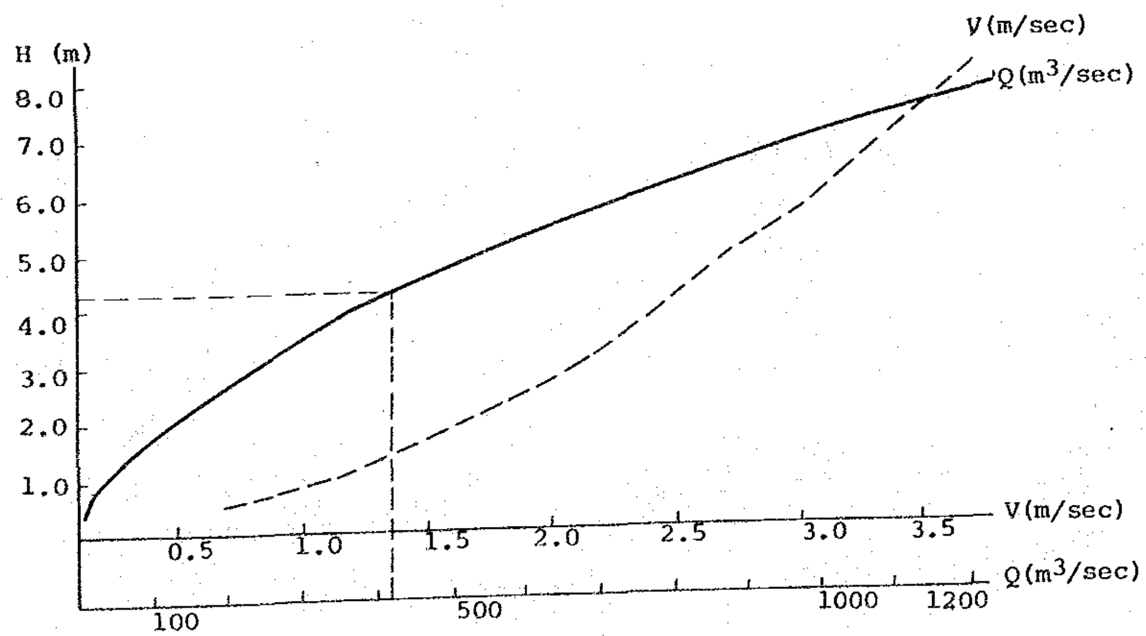
BRIDGE NO.3 (Via River)

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 20.1km



Q = 415.0 m^3/sec i = 0.002 n = 0.04

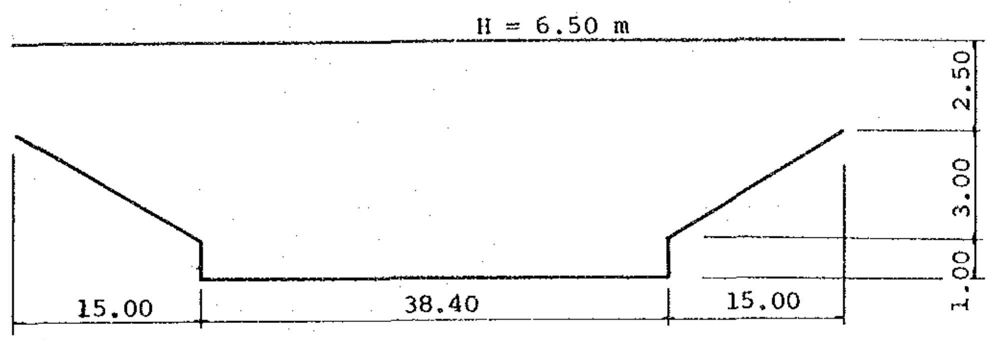
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
1.00	34.60	36.43	0.950	0.966	0.0447	1.080	37.37
1.50	52.65	37.84	1.391	1.246	"	1.393	73.33
2.00	71.20	39.26	1.814	1.487	"	1.662	118.33
3.00	109.80	42.09	2.609	1.895	"	2.118	232.53
4.00	151.65	47.14	3.217	2.179	"	2.435	369.27
5.00	197.50	51.78	3.814	2.441	"	2.728	538.79
6.00	245.10	53.78	4.557	2.749	"	3.072	752.91
7.00	292.70	55.78	5.247	3.020	"	3.375	987.72
8.00	340.30	57.78	5.890	3.261	"	3.645	1240.23



ZORZOR - VOINJAMA

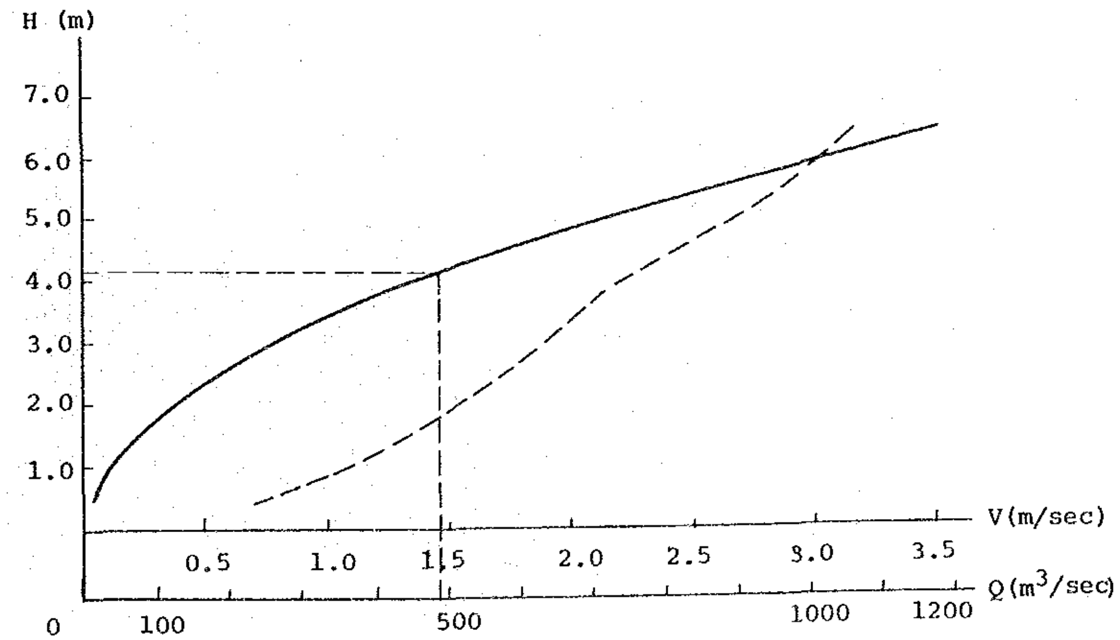
BRIDGE NO.10 (Lawa River)

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 49.5km



Q = 484.0 m^3/sec i = 0.002 n = 0.04

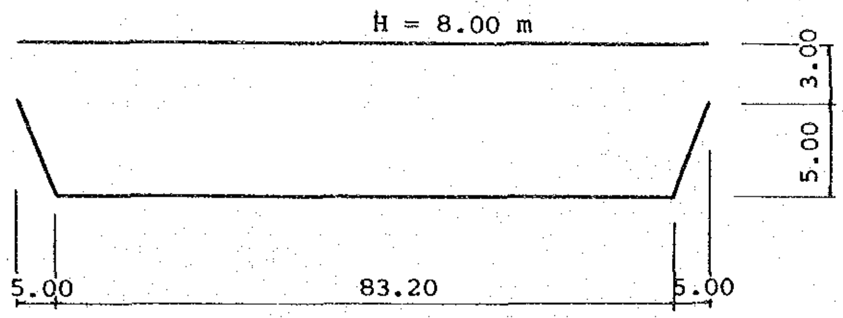
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
1.00	38.40	40.40	0.950	0.967	0.0447	1.081	41.51
2.00	81.80	50.60	1.617	1.377	"	1.539	125.89
3.00	135.20	60.80	2.224	1.704	"	1.904	257.42
4.00	198.60	70.99	2.798	1.985	"	2.219	440.69
5.00	267.00	72.99	3.658	2.374	"	2.653	708.35
6.00	335.40	74.99	4.473	2.715	"	3.034	1017.60
6.50	369.60	76.99	4.801	2.846	"	3.180	1175.33



ZORZOR - VOINJAMA

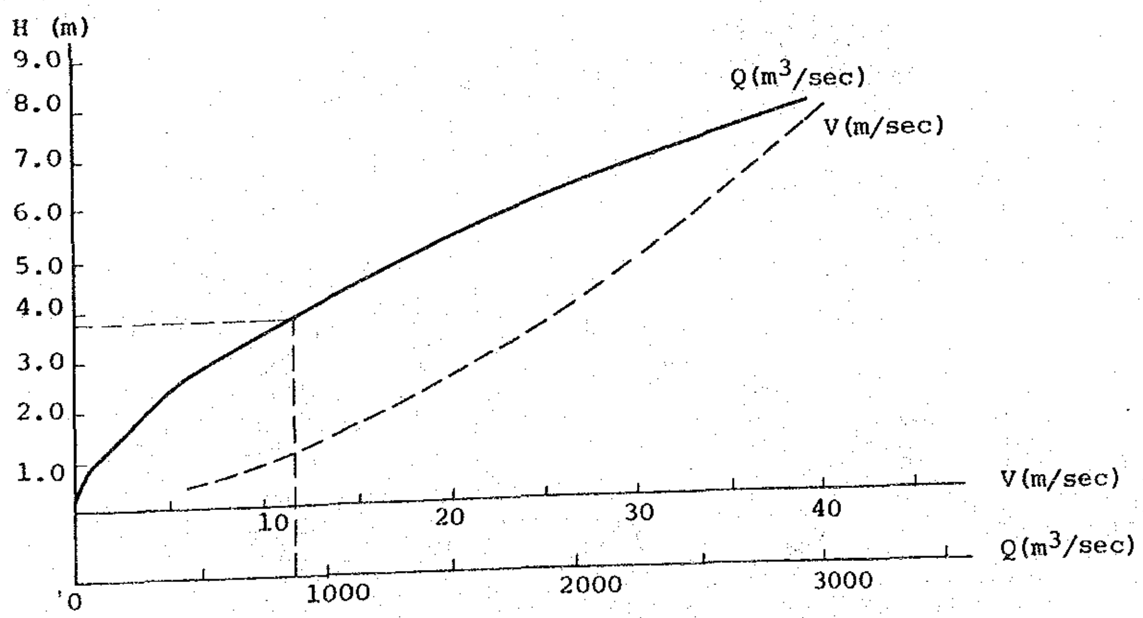
BRIDGE NO.12 (Lofa River)

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 68.0km



$Q = 879.70\ m^3/sec$ $i = 0.002$ $n = 0.04$

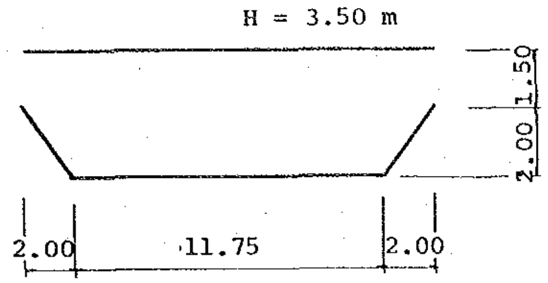
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
1.00	84.20	86.03	0.979	0.986	0.0447	1.102	92.79
2.00	170.40	88.86	1.918	1.544	"	1.725	293.94
3.00	258.60	91.69	2.820	1.996	"	2.231	576.94
4.00	348.80	94.51	3.691	2.388	"	2.669	930.95
5.00	441.00	94.34	4.531	2.738	"	3.060	1349.46
6.00	534.20	99.34	5.377	3.069	"	3.430	1832.31
7.00	627.40	101.34	6.191	3.372	"	3.768	2364.04
8.00	720.60	103.34	6.973	3.650	"	4.079	2939.33



VOINJAMA - MENDIKOMA

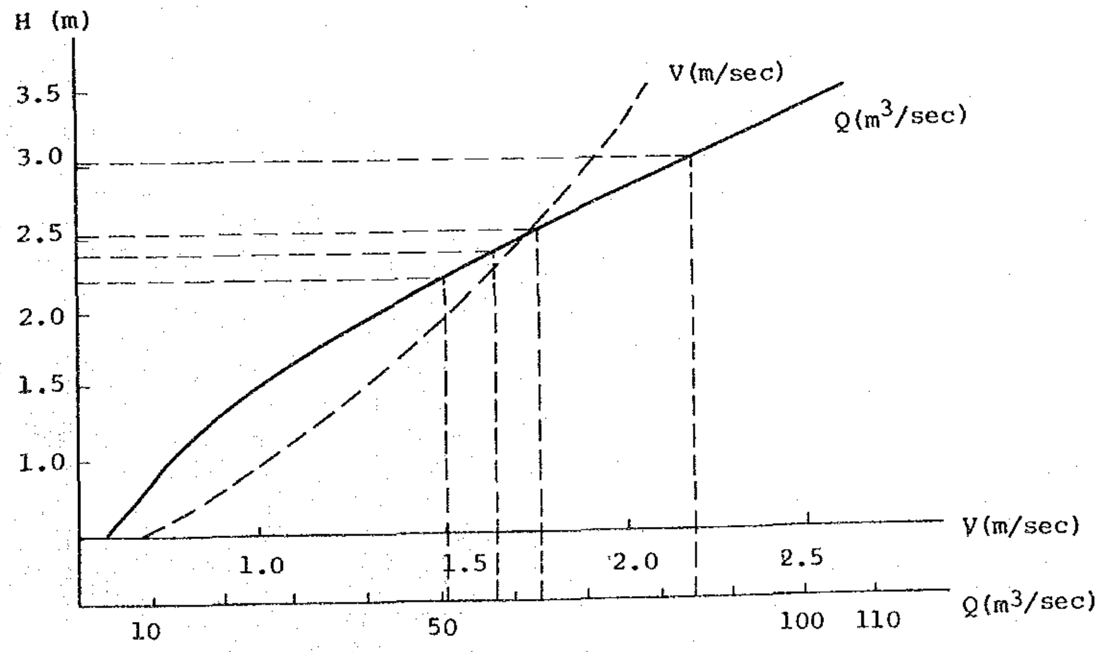
BRIDGE NO.1

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 7.7km



$Q = 84.28\ m^3/sec$ $i = 0.002$ $n = 0.04$

H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	6.13	13.16	0.466	0.601	0.0447	0.672	4.12
1.00	12.75	14.58	0.874	0.914	"	1.021	13.02
1.50	19.88	15.99	1.243	1.156	"	1.292	25.68
2.00	27.50	17.41	1.580	1.356	"	1.515	41.66
2.50	35.38	18.41	1.922	1.546	"	1.727	61.10
3.00	43.25	19.41	2.228	1.706	"	1.906	82.43
3.50	51.13	20.41	2.505	1.845	"	2.062	105.43

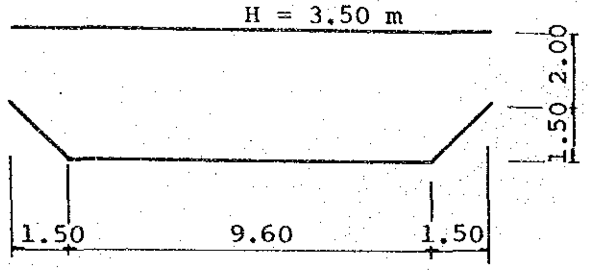


Analysis Result (5)

VOINJAMA - MENDIKOMA

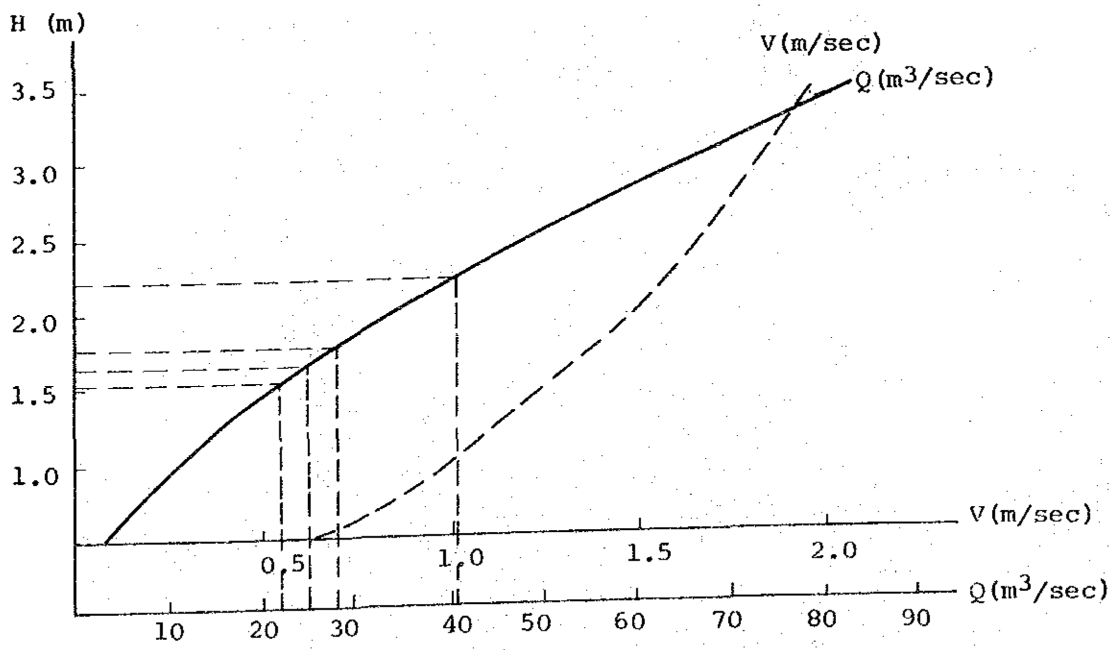
BRIDGE NO.3

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 43.2km



$Q = 40.85\ m^3/sec$ $i = 0.002$ $n = 0.04$

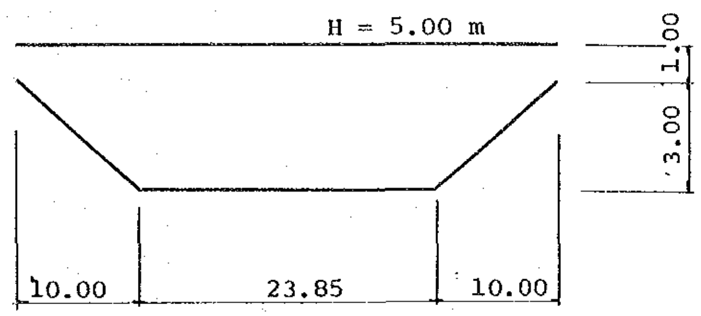
H (m)	A (m^2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	5.05	11.01	0.459	0.595	0.0447	0.665	3.36
1.00	10.60	12.43	0.853	0.899	"	1.005	10.65
1.50	16.65	13.84	1.203	1.131	"	1.264	21.05
2.00	22.95	14.84	1.546	1.337	"	1.494	34.29
2.50	29.25	15.84	1.847	1.505	"	1.682	49.20
3.00	35.55	16.84	2.111	1.646	"	1.839	65.38
3.50	41.85	17.84	2.346	1.766	"	1.974	82.61



VOINJAMA - MENDIKOMA

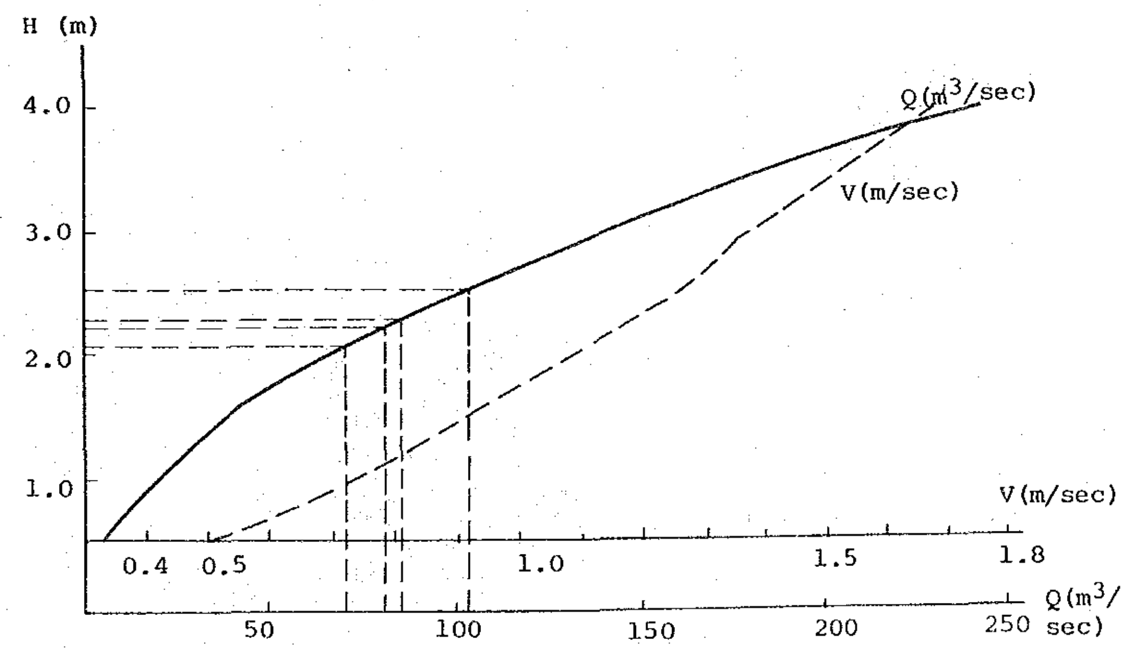
BRIDGE NO.4

HYDRAULIC CROSS-SECTION OF THE CREEK FOR BRIDGE at 70.1km



$Q = 85.53\ m^3/sec$ $i = 0.001$ $n = 0.04$

H (m)	A (m2)	P (m)	R	$R^{\frac{2}{3}}$	$I^{\frac{1}{2}}$	V (m/sec)	Q (m^3/sec)
0.50	12.76	27.33	0.467	0.602	0.0316	0.476	6.07
1.00	27.18	30.81	0.882	0.920	"	0.727	19.76
1.50	43.28	34.29	1.262	1.168	"	0.923	39.95
2.00	61.03	37.77	1.616	1.377	"	1.088	66.40
2.50	80.46	41.25	1.951	1.561	"	1.233	99.21
3.00	101.55	44.73	2.270	1.727	"	1.364	138.51
4.00	145.40	46.73	3.111	2.131	"	1.683	244.71



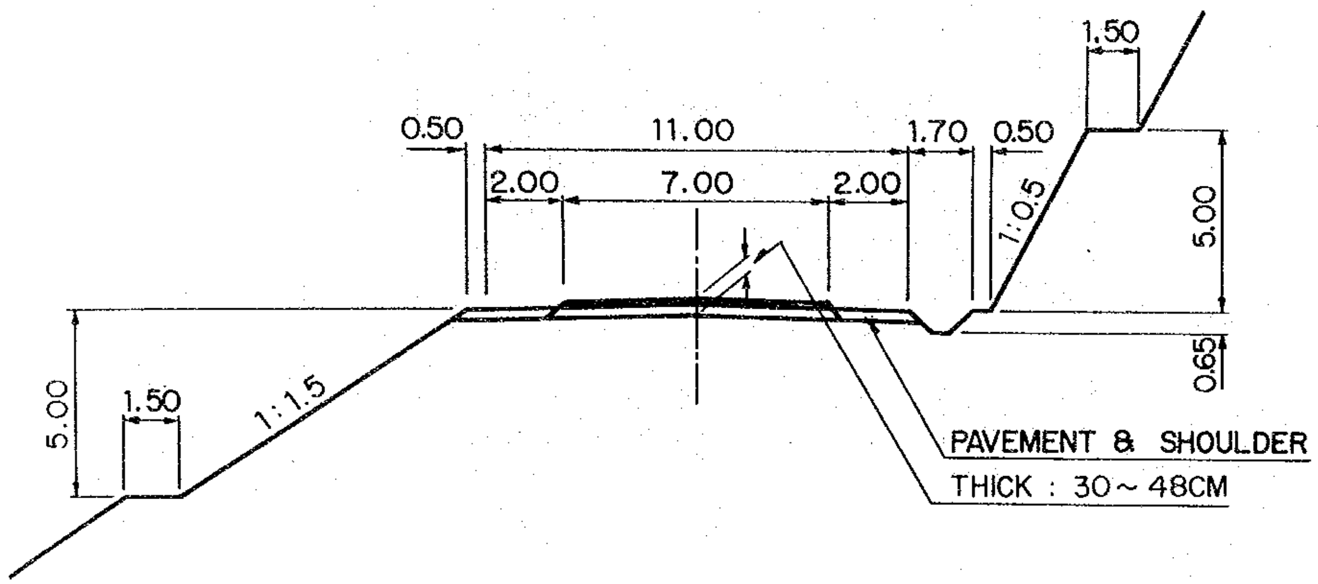
〔IV〕

TYPICAL CROSS SECTION AND PAVEMENT STRUCTURE, AND DRAINAGE STRUCTURE

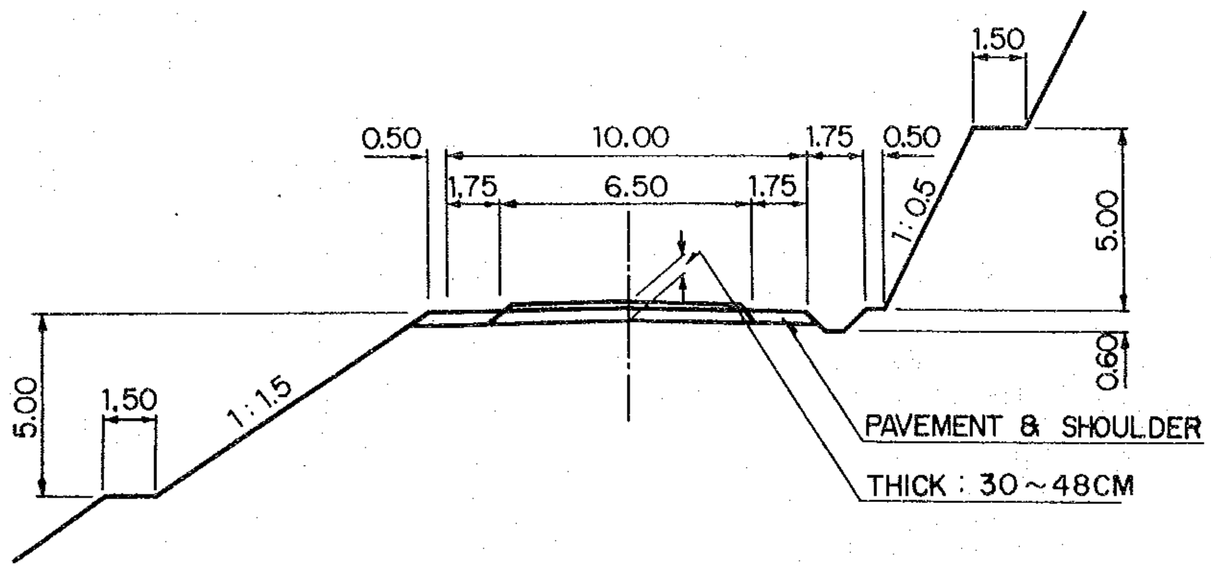
GBARNGA-MENDIKOMA HIGHWAY PROJECT FEASIBILITY STUDY	SHEET No.
TYPICAL CROSS SECTIONS	DWG. IV-1

(UNIT : M)

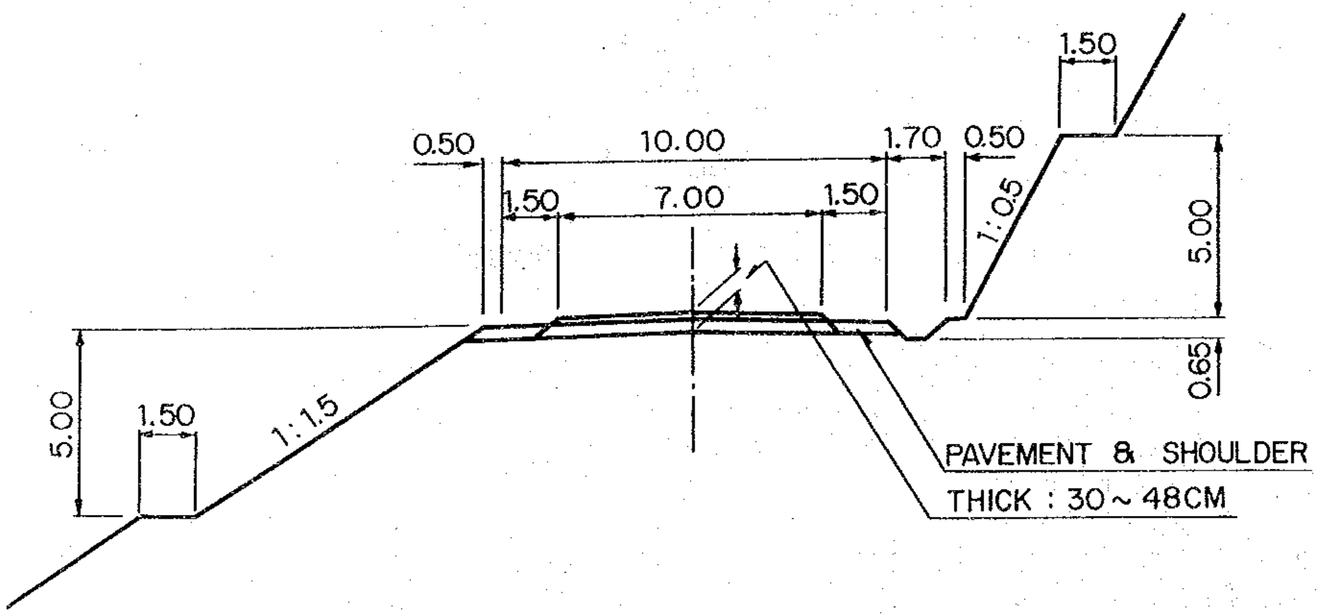
DESIGN SPEED 80km/h (LOFA RIVER-VOINJAMA-SHELLO)



DESIGN SPEED 60km/h (KONIA-LOFA RIVER)



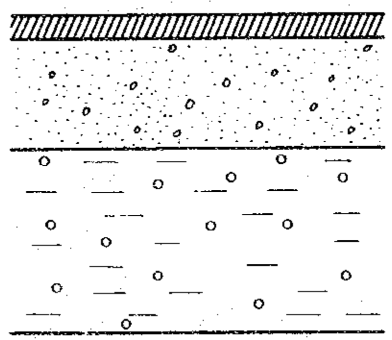
DESIGN SPEED 80km/h (GBARNGA-KONIA. SHELLO-MENDIKOMA)



PAVEMENT STRUCTURE

(10 YEARS STAGE-WIZE CONSTRUCTION METHOD)

1ST STAGE

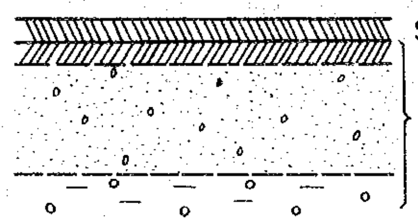


SURFACE COURSE
HOTMIX ASPHALT CONCRETE — THICK : 3CM (I~V)

BASE COURSE
CEMENT STABILIZED — THICK : 12 CM (I.III.V), 15 CM (II.IV)

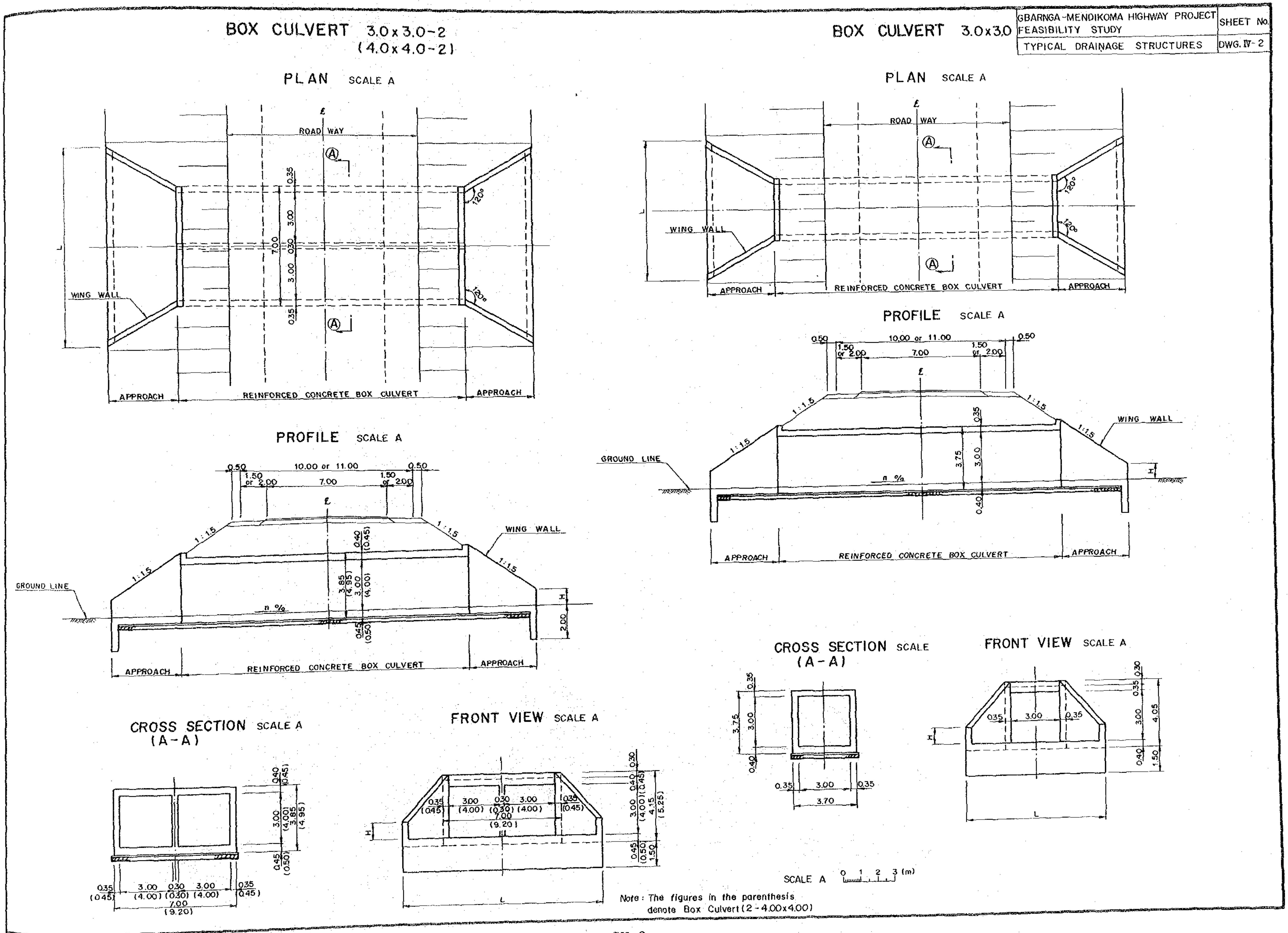
SUB BASE COURSE
SELECTED LATERITE — THICK : 15 CM (II.V), 20CM (I), 30CM (III.IV)

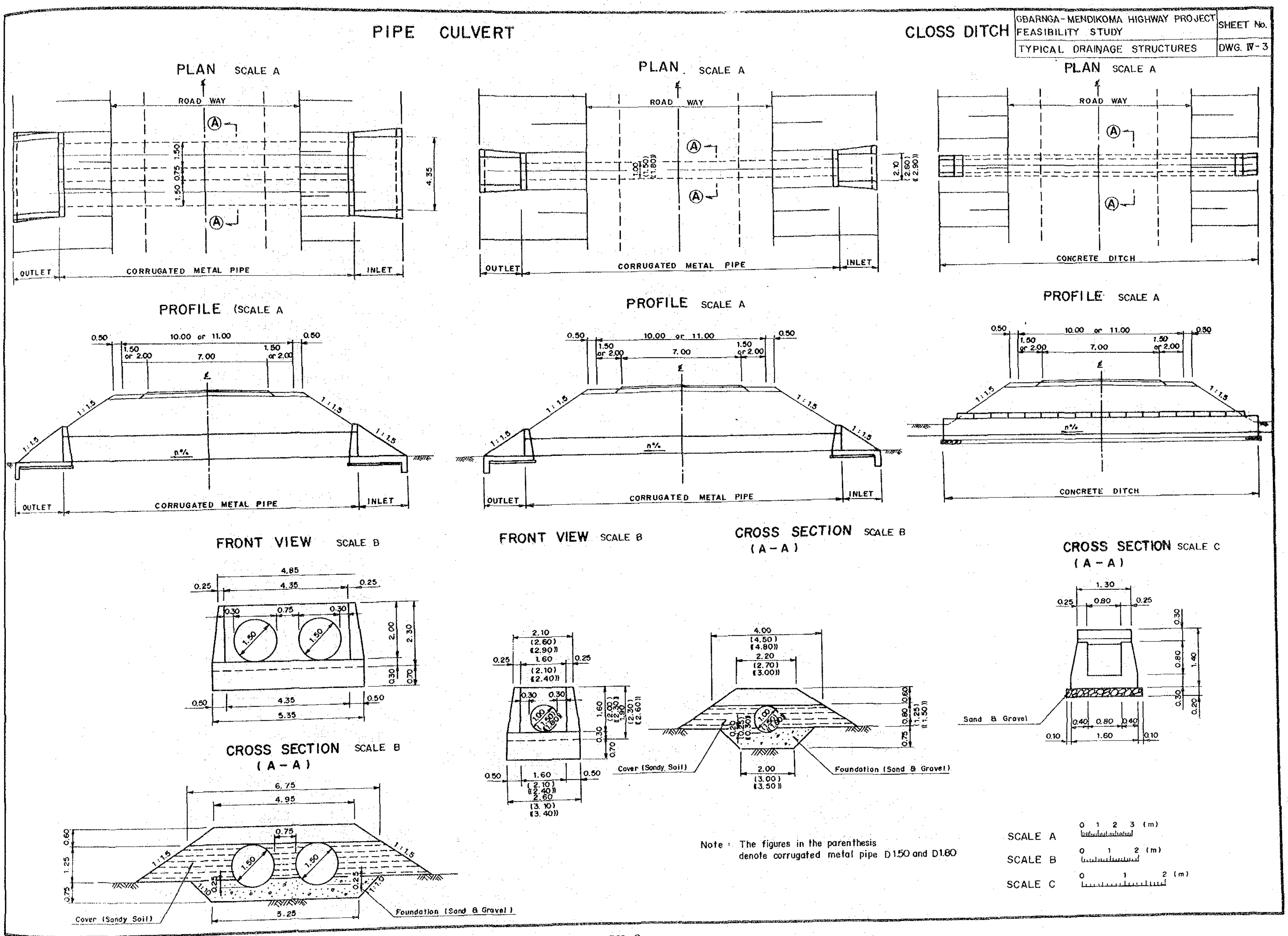
2ND STAGE (AFTER 10 YEARS OVERLAY)

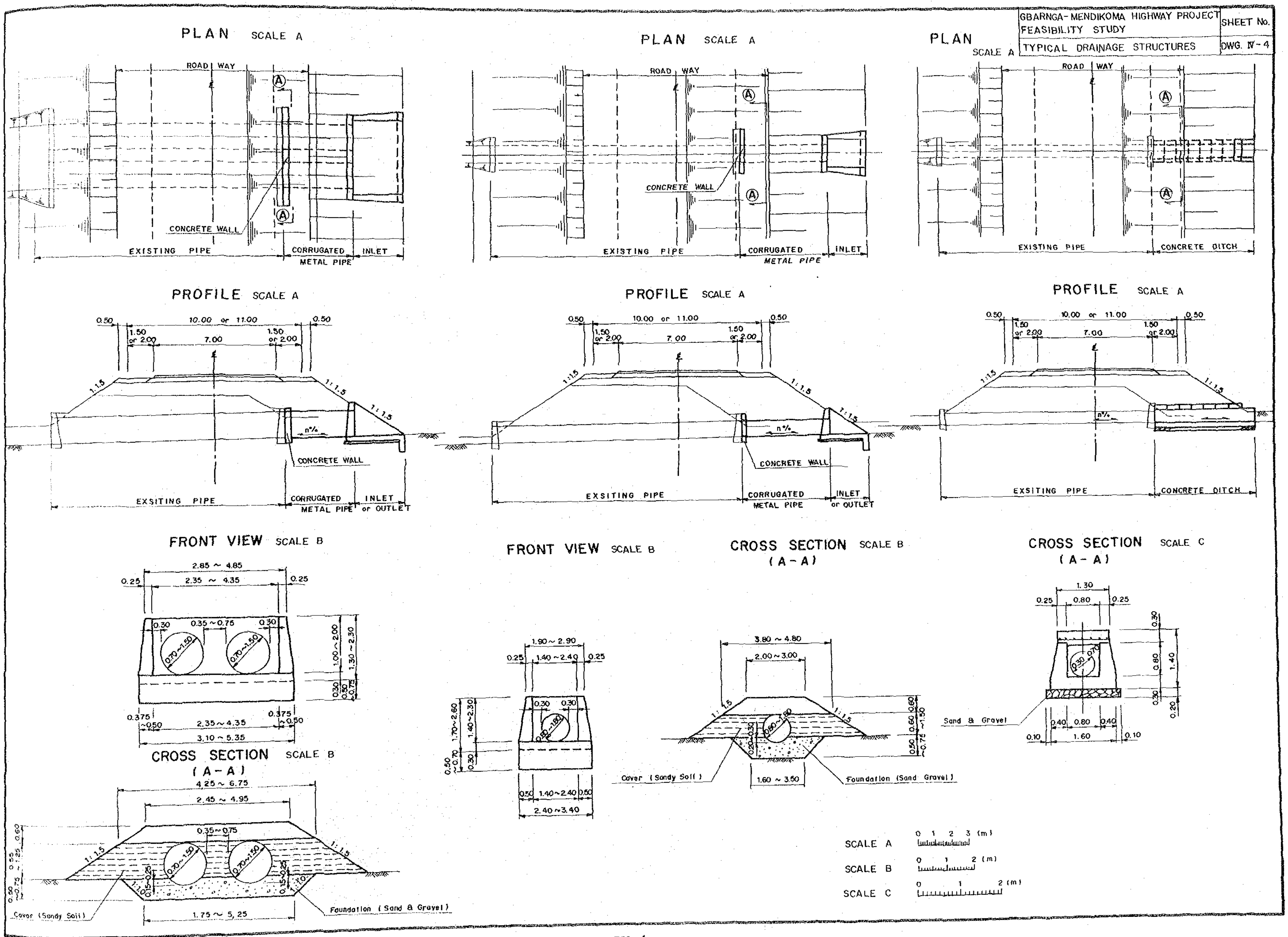


SURFACE COURSE
ROADMIX ASPHALT TREATMENT — THICK : 3 CM (I.II.III.IV), 1.5CM (V)

1ST STAGE PAVEMENT

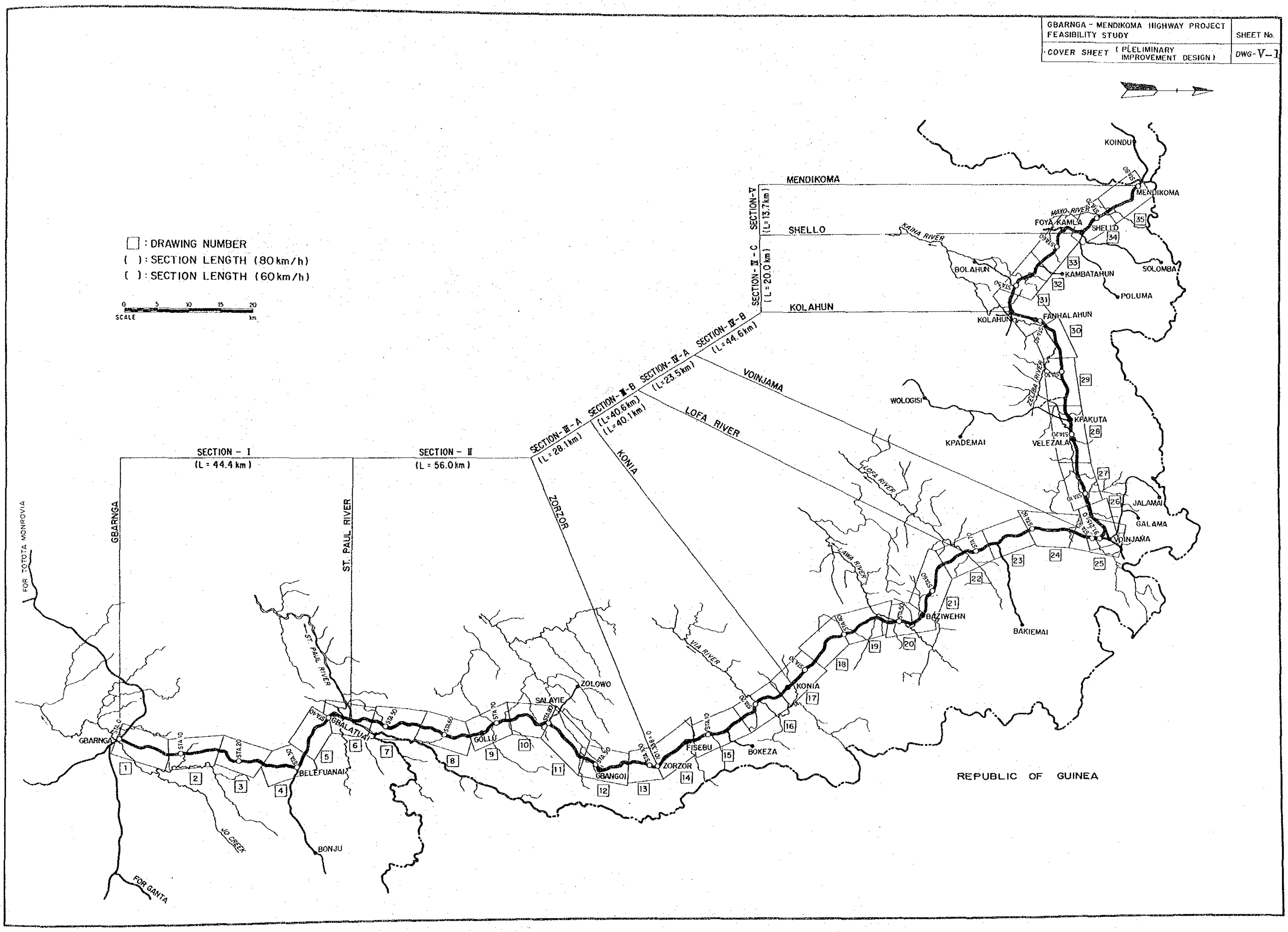

GBARNGA-MENDIKOMA HIGHWAY PROJECT
FEASIBILITY STUDY
SHEET No.
TYPICAL DRAINAGE STRUCTURES
DWG. IV-2
BOX CULVERT 3.0x3.0-2
(4.0x4.0-2)
PLAN SCALE A
ROAD WAY
WING WALL
APPROACH
REINFORCED CONCRETE BOX CULVERT
APPROACH
PROFILE SCALE A
10.00 or 11.00
1.50 or 2.00
7.00
GROUND LINE
WING WALL
n %
CROSS SECTION SCALE A
(A-A)
FRONT VIEW SCALE A
Note: The figures in the parenthesis denote Box Culvert (2-4.00x4.00)
BOX CULVERT 3.0x3.0
PLAN SCALE A
ROAD WAY
WING WALL
APPROACH
REINFORCED CONCRETE BOX CULVERT
APPROACH
PROFILE SCALE A
10.00 or 11.00
1.50 or 2.00
7.00
GROUND LINE
WING WALL
n %
CROSS SECTION SCALE
(A-A)
FRONT VIEW SCALE A
SCALE A 0 1 2 3 (m)


GBARNGA-MENDIKOMA HIGHWAY PROJECT
FEASIBILITY STUDY
TYPICAL DRAINAGE STRUCTURES
SHEET No.
DWG. IV-3
PIPE CULVERT
CLOSS DITCH
PLAN SCALE A
ROAD WAY
CORRUGATED METAL PIPE
OUTLET
INLET
CONCRETE DITCH
PROFILE SCALE A
10.00 or 11.00
7.00
1.50 or 2.00
0.50
1:1.5
n%
FRONT VIEW SCALE B
CROSS SECTION SCALE B
(A – A)
CROSS SECTION SCALE C
Cover (Sandy Soil)
Foundation (Sand & Gravel)
Sand & Gravel
Note : The figures in the parenthesis denote corrugated metal pipe D1.50 and D1.80
SCALE A
SCALE B
SCALE C


GBARNGA-MENDIKOMA HIGHWAY PROJECT
FEASIBILITY STUDY
TYPICAL DRAINAGE STRUCTURES
SHEET No.
DWG. IV-4
PLAN SCALE A
ROAD WAY
CONCRETE WALL
EXISTING PIPE
CORRUGATED METAL PIPE
INLET
CONCRETE DITCH
PROFILE SCALE A
10.00 or 11.00
7.00
1.50 or 2.00
0.50
1:1.5
CONCRETE WALL
EXSITING PIPE
INLET or OUTLET
FRONT VIEW SCALE B
2.85 ~ 4.85
2.35 ~ 4.35
0.25
0.35 ~ 0.75
0.30
0.70~1.50
3.10 ~ 5.35
CROSS SECTION SCALE B
(A-A)
4.25 ~ 6.75
2.45 ~ 4.95
1.75 ~ 5.25
Cover (Sandy Soil)
Foundation (Sand & Gravel)
1.90 ~ 2.90
1.40 ~ 2.40
2.40 ~ 3.40
3.80 ~ 4.80
2.00 ~ 3.00
1.60 ~ 3.50
CROSS SECTION SCALE C
(A-A)
1.30
0.80
1.60
1.40
Sand & Gravel
SCALE A
SCALE B
SCALE C

〔V〕

PRELIMINARY IMPROVEMENT DESIGN


GBARNGA - MENDIKOMA HIGHWAY PROJECT FEASIBILITY STUDY
SHEET No.
COVER SHEET (PLELIMINARY IMPROVEMENT DESIGN)
DWG- V-1
□ : DRAWING NUMBER
( ) : SECTION LENGTH (80 km/h)
( ) : SECTION LENGTH (60 km/h)
0 5 10 15 20
SCALE
km
SECTION - I
(L = 44.4 km)
SECTION - II
(L = 56.0 km)
SECTION-III-A
(L = 28.1 km)
SECTION-III-B
(L = 40.6 km)
(L = 40.1 km)
SECTION-IV-A
(L = 23.5 km)
SECTION-IV-B
(L = 44.6 km)
SECTION-IV-C
(L = 20.0 km)
SECTION-V
(L = 13.7 km)
GBARNGA
ST. PAUL RIVER
ZORZOR
KONIA
LOFA RIVER
VOINJAMA
KOLAHUN
SHELLO
MENDIKOMA
FOR TOTOTA MONROVIA
FOR GANTA
JO CREEK
BONJU
BELEFUANAI
GBALATUAI
GOLLU
SALAYIE
ZOLOWO
GBANGOI
FISEBU
BOKEZA
VIA RIVER
LAWA RIVER
BAZIWEHN
BAKIEMAI
KPADEMAI
WOLOGISI
VELEZALA
KPAKUTA
ZELGBA RIVER
FANHALAHUN
KAMBATAHUN
POLUMA
SOLOMBA
BOLAHUN
KAIHA RIVER
FOYA KAMLA
MAYO RIVER
KOINDU
JALAMAI
GALAMA
REPUBLIC OF GUINEA