

2.4 Construction Material

The following materials are required for the embankment of rockfill dam and the concrete for appurtenant facilities.

- Aggregate
- Impervious Material
- Semi-pervious Material
- Pervious Material

To collect such necessary information and data on aggregate for concrete and embankment material as quality and available quantity, drilling works, seismic prospecting works, test pit excavation and soil and rock mechanical laboratory tests were executed.

The work items and quantities of construction material survey in the study period of Phase 1 and Phase 2 are shown in the following table.

Aggregate

Study Period	Work Item	Work Quantities
Phase 1	Core Drilling (D=66 mm)	13 holes, 710 m in total
	Seismic Prospecting	5 lines, 1,700 m in total
	Laboratory Test of Core Sample	20 samples
	Alkali-Aggregate Reaction Test	5 samples

Non-mixed Impervious Material

Study Period	Work Item	Work Quantities
Phase 2	Core Drilling (D=66 mm)	20 holes, 200 m in total
	Test Pit	12 pits
	Physical Property Test including tests of specific gravity, water content, liquid limit, plastic limit and particle-size analysis	24 samples
	Moisture-Density Relation Test (D=100 mm)	24 samples
	Consolidated Undrained Triaxial Compression Test (D=100 mm)	24 samples
	Permeability Test (D=100 mm)	24 samples

Mixed Impervious Material

Study Period	Work Item	Work Quantities
Phase 2	Physical Property Test including tests of specific gravity, absorption, water content, liquid limit, plastic limit and particle-size analysis	5 samples
	Moisture-Density Relation Test (D=100 mm)	5 samples
	Consolidated Undrained Triaxial Compression Test (D=100 mm)	5 samples
	Permeability Test (D=100 mm)	4 samples

Non-mixed Semi-pervious Material

Study Period	Work Item	Work Quantities
Phase 2	Core Drilling (D=66 mm)	7 holes, 70 m in total
	Test Pit	8 pits
	Physical Property Test including tests of specific gravity, absorption, water content and particles-size analysis	8 samples

Mixed Semi-pervious Material

Study Period	Work Item	Work Quantities
Phase 2	Relative Density Test (D=100 mm)	4 samples
	Consolidated Drained Triaxial Compression Test (D=100 mm)	4 samples
	Permeability Test (D=100 mm)	4 samples

Location Map of Borrow Area A, B, C, and D are shown in Figure 2.4.7, and the location Map of the Core Drilling and Test Pit Excavation in Borrow Area A, B, and C are shown in Figure 2.4.8, Figure 2.4.9, and Figure 2.4.10 respectively.

Pervious Material

Study Period	Work Item	Work Quantities
Phase 2	Sampling including sieving works	1 samples
	Physical Property Test including tests of specific gravity, absorption and particles-size analysis	7 samples
	Large Scale Relative Density Test (D=300 mm)	1 samples
	Large Scale Consolidated Drained Triaxial Compression Test (D=300 mm)	4 samples
	Large Scale Permeability Test (D=300 mm)	3 samples

2.4.1 Aggregate

(1) Core Drilling

The detail of investigation items and quantities of Drilling Work at Quarry Site are as follow:

Stage	Hole No.	Hole Diameter (mm)	Ground Elevation (EL.m)	Depth (m)	Coordinate	
					X	Y
Phase I	A - 1	66	571.511	100	436,932.016	9,207,800.189
	A - 2	66	563.482	90	437,030.778	9,207,808.231
	A - 3	66	554.988	80	437,129.317	9,207,817.536
	A - 4	66	520.844	50	437,249.498	9,207,828.517
	A - 5	66	498.254	30	437,320.527	9,207,834.885
	A - 6	66	540.245	70	436,942.249	9,207,700.785
	A - 7	66	539.589	70	437,036.773	9,207,710.026
	A - 8	66	525.464	50	437,136.266	9,207,721.155
	A - 9	66	50.165	40	437,259.474	9,207,730.286
	A - 10	66	507.931	40	436,948.624	9,207,605.872
	A - 11	66	493.879	30	437,046.314	9,207,614.359
	A - 12	66	498.380	30	437,145.159	9,207,621.448
	A - 13	66	486.567	30	437,267.859	9,207,637.294
Total				710		

The Location Map of Core Drilling in Quarry Site is shown in Figure 2.4.1, Bore Holes Locations and Line Seismic for Quarry Site. The results of core drillings are shown in Photo Album.

(2) Seismic Prospecting

The detail of investigation items and quantities of Seismic Prospecting at Quarry Site are as follows:

Stage	Line Name	Location	Quantities (m)	Remarks
Phase I	S - 1	Ridge Part	460	
	S - 2	Slope Part	340	
	S - 3	Slope Part	300	
	S - 4	Slope Part	300	
	S - 5	Slope Part	300	
Total			1,700	

The geophysical campaign done at Quarry Site Consists of 1700 meters refraction seismic line, were distributed along five seismic lines as shown in Figure 2.4.1. They are five lines for 60 m penetration, namely Line S - 01 at the ridge part and Line S - 02 , Line S - 03, Line S - 04, and Line S - 05 at the slope part.

The result of investigation consists of T – X Graph and Seismic Section Line S – 01, S – 02, S – 03, S – 04, and S – 05 as shown in Figure 2.4.15 to Figure 2.4.19. The classified seismic velocity and kind of rock for Line S – 01 to Line S – 05 are shown in Table 2.4.1 to Table 2.4.5.

(3) Laboratory Test of Core Sample and Aggregate

The detail of investigation items and quantities of Laboratory Test of Core Sample and Aggregate are as follows:

Stage	Work Items		Quantities (m)	Remarks
Phase 1	Alkali-Aggregate Reaction Test	Microscope Observation, X-ray Analysis, Chemical Method and Mortar Bar	5	
	Physical Property Test	Density, Absorption Ratio and Effective	35	
	Unconfined Compression Test		20	

The results of Laboratory Test of Core Sample and Aggregate are shown Photo Album and the Chemical Analysis Results of the dried sample are shown in Table 2.4.8.

2.4.2 Impervious Material

(1) Non-Mixed Impervious Material

- Core Drilling

The detail of investigation items and quantities of drilling works at Borrow Area A and Borrow Area B are as follows:

Borrow Area A

Stage	Hole No.	Hole Diameter (mm)	Ground Elevation (EL.m)	Depth (m)	Coordinate	
					X	Y
Phase 2	BA – 1	66	214.231	10	427,577.519	9,220,655.936
	BA – 2	66	218.607	10	427,777.668	9,220,657.043
	BA – 3	66	216.462	10	427,578.654	9,220,454.723
	BA – 4	66	216.204	10	427,777.668	9,220,456.538
	BA – 5	66	198.518	10	427,580.020	9,220,252.949
	BA – 6	66	215.990	10	427,790.818	9,220,257.887
Total				60		

Borrow Area B

Stage	Hole No.	Hole Diameter (mm)	Ground Elevation (EL.m)	Depth (m)	Coordinate	
					X	Y
Phase 2	BB - 1	66	186.79	10	427,460.992	9,222,588.124
	BB - 2	66	183.14	10	427,760.989	9,222,839.989
	BB - 3	66	170.76	10	427,995.240	9,223,002.648
	BB - 4	66	190.28	10	427,613.491	9,222,495.177
	BB - 5	66	187.24	10	427,884.216	9,222,688.538
	BB - 6	66	187.36	10	428,130.924	9,222,865.362
	BB - 7	66	189.40	10	427,630.907	9,222,746.571
	BB - 8	66	177.06	10	427,883.660	9,222,932.872
	BB - 9	66	185.17	10	427,745.882	9,222,577.891
	BB - 10	66	182.18	10	427,998.339	9,222,769.092
	BB - 11	66	180.23	10	428,231.731	9,222,951.623
	BB - 12	66	177.24	10	428,354.873	9,223,037.841
	BB - 13	66	172.72	10	428,177.338	9,223,035.381
	BB - 14	66	181.89	10	428,287.646	9,222,868.725
Total				140		

All results of core drilling from Borrow Area A and Borrow Area B are shown in Photo Album.

- Test Pit Excavation

The detail of investigation items and quantities of Test Pit Excavation Works at Borrow Area A, Borrow Area B and Borrow Area D are as follows:

Borrow Area A

Stage	Pit No.	Sampling Depth (m)	Ground Elevation (m)	Depth (m)	Coordinate	
					X	Y
Phase 2	TPA - 1	2.50, 4.50	216.650	5.00	427,656.365	9,220,605.249
	TPA - 2	2.00, 4.00	216.213	5.00	427,656.365	9,220,505.249
	TPA - 3	2.00, 4.00	214.095	5.00	427,683.448	9,220,403.383
	TPA - 4	1.50, 3.00	213.239	4.40	427,686.341	9,220,304.287
Total						

Borrow Area B

Stage	Pit No.	Sampling Depth (m)	Ground Elevation (m)	Depth (m)	Coordinate	
					X	Y
Phase 2	TPB - 1	2.00, 4.50	190.46	4.90	427,565.923	9,222,573.977
	TPB - 2	2.00, 4.00	187.15	4.50	427,688.264	9,222,659.597
	TPB - 3	2.00, 4.00	183.00	4.80	428,169.273	9,222,909.494
	TPB - 4	2.50, 4.00	178.71	4.60	428,293.494	9,222,994.857
	TPB - 5	2.00, 4.60	172.26	4.60	428,297.075	9,223,123.024
	TPB - 6	3.00, 5.00	181.08	5.00	428,349.404	9,222,911.969
Total						

Borrow Area D

Stage	Pit No.	Sampling Depth (m)	Ground Elevation (m)	Depth (m)	Coordinate	
					X	Y
Phase 2	TPD - 1	2.50, 4.50	150.131	4.80	428228.059	9222305.693
	TPD - 2	2.00, 3.50	139.759	4.90	428258.511	9222352.942
Total						

The result of the test pit of the Borrow Area A, Borrow Area B and Borrow Area D in the form of log of test pit are shown in Photo Album.

- Laboratory Testing

Summary of Laboratory Testing for Non-Mixed Impervious material is shown in Table 2.4.9 Summary of Laboratory Test (fine material of Borrow Area).

(2) Mixed Impervious Material

Summary of Laboratory Testing for Mixed Impervious Material is shown in Table 2.4.10 Summary of Laboratory Test (Mixed Material Crushed rock and Fine Material).

2.4.3 Semi Pervious Material

(1) Non-Mixed Semi Pervious

- Core Drilling

The investigation items and work quantities of Drilling work for Borrow Area C are as follows:

Stage	Hole No.	Hole Diameter (mm)	Ground Elevation (EL.m)	Depth (m)	Coordinate	
					X	Y
Phase 2	BC - 1	66	122.081	10	427,726.689	9,221,666.600
	BC - 2	66	121.515	10	427,758.630	9,221,600.360
	BC - 3	66	124.355	10	427,756.739	9,221,500.378
	BC - 4	66	125.484	10	427,754.848	9,221,400.396
	BC - 5	66	127.822	10	427,752.957	9,221,300.414
	BC - 6	66	122.529	10	427,658.290	9,221,602.111
	BC - 7	66	124.184	10	427,657.011	9,221,398.701
Total				100		

All results of core drilling from Borrow Area C are shown in Photo Album.

- Test Pit Excavation

The detail of investigation items and quantities of Test Pit Excavation Works at Borrow Area C are as follows:

Stage	Pit No.	Sampling Depth (m)	Ground Elevation (m)	Depth (m)	Coordinate	
					X	Y
Phase 2	TPC - 1	1.50	121.380	2.20	427,660.320	9,221,702.146
	TPC - 2	2.00	121.137	3.20	427,722.967	9,221,600.405
	TPC - 3		126.680	4.00	427,860.461	9,221,394.423
	TPC - 4	2.50	122.180	5.00	427,758.724	9,221,720.230
	TPC - 5		123.120	2.40	427,958.721	9,221,800.512
	TPC - 6	2.50	123.008	3.20	427,559.878	9,221,698.820
	TPC - 7		124.184	2.50	427,556.060	9,221,398.647
	TPC - 8		129.402	3.40	427,655.301	9,221,196.295
Total						

The results of the test pit of the Borrow Area C in the form of log of test pit are shown in Photo Album.

(2) Mixed Semi-Pervious Material

- Laboratory testing

Summary of Laboratory test for Non-Mixed and Mixed Semi-Pervious Material are shown in Table 2.4.11 Summary of Laboratory Test (Coarse Material: Borrow Area, Crushed Rock and Natural Sand).

2.4.4 Pervious Material

- Rock Sampling

As mentioned in Section 2.1.8 above, the rock quarry sampling was executed by manual excavation of the private mining area, that was by using pick hammer, chisel, and crowbar.

After block samples has been accumulated, the samples were to be crushed in order to get specific size and weight as mentioned in the specification. The result of Grain size Analysis for test is shown in Figure 2.4.11.

- The Laboratory Test Results (large Scale)

The Laboratory Test Results are shown in Table 2.4.12 Summary of Soil Test Result (1), Table 2.4.13 , and Table 2.4.14 for Summary of Soil Test Result (2) and Summary of Soil Test Result (3) (Triaxial Compression Test) respectively, including

Physical Property Test, Large Scale Relative Density Test (D300 mm), Large Scale consolidated Drained Triaxial Compression Test (D300 mm) and Large Scale Permeability Test (D300 mm).

Tables

Table 1.1.1 Final Result of Control Points

DATUM : WGS84
 PROJECTION : U.T.M
 ZONE : 49
 SEMI-MAJOR AXIS : 6,378,137.0000
 MINI-MINOR AXIS : 6,356,752.4143
 FLATTERING : 298.2572236
 SCALE FACTOR : 0.9996000
 LATITUDE OF ORIGIN : 00° 0' 0" 0000
 LONGITUDE OF ORIGIN : 111° 0' 0" 0000E

STATION	NORTHING	EASTING	LATITUDE	LONGITUDE	ELEVATION	REMARKS
N.004	7° 04' 7.0809" S	110° 28' 55.8562" E	9,218,632.118	442,814.138		
N1.0259 (JP-7)	6° 59' 1.5641" S	110° 24' 34.2824" E	9,228,004.682	434,777.817	4.362	
JP - 1	6° 56' 51.3269" S	110° 25' 6.6671" E	9,232,005.355	435,766.570	0.922	
JP - 2	6° 56' 28.9296" S	110° 26' 41.9642" E	9,232,696.655	438,690.025	1.015	
JP - 3	6° 56' 47.2163" S	110° 25' 32.0770" E	9,232,127.943	432,863.829	0.926	
JP - 4	6° 57' 46.8455" S	110° 25' 59.5975" E	9,230,302.408	437,386.684	0.744	
JP - 5	6° 58' 38.3085" S	110° 26' 54.6029" E	9,228,724.049	439,082.490	2.999	
JP - 6	6° 58' 26.1345" S	110° 25' 40.1529" E	9,229,090.579	433,115.536	0.986	
JP - 8	6° 59' 9.3077" S	110° 25' 43.6724" E	9,227,769.509	436,907.230	2.864	
JP - 9	6° 59' 46.0844" S	110° 23' 22.6952" E	9,226,634.706	432,582.979	53.702	
JP - 10	7° 00' 19.0705" S	110° 26' 56.3074" E	9,225,629.855	439,138.413	7.980	
JP - 11	7° 00' 18.8507" S	110° 25' 40.3323" E	9,225,633.799	436,807.342	14.416	
JP - 12	7° 00' 22.1649" S	110° 24' 30.8753" E	9,225,529.584	434,676.387	86.673	
JP - 13	7° 00' 44.3283" S	110° 22' 14.3173" E	9,224,843.319	430,487.408	60.949	
JP - 14	7° 01' 23.1271" S	110° 23' 19.3198" E	9,223,654.479	432,483.354	34.648	
JP - 15	7° 01' 32.2396" S	110° 22' 16.3507" E	9,223,372.085	430,551.770	80.953	
JP - 16	7° 01' 37.6491" S	110° 20' 54.4400" E	9,223,202.528	428,038.896	184.599	
JP - 17	7° 03' 1.1278" S	110° 21' 33.5130" E	9,220,640.610	429,241.206	204.198	
JP - 18	7° 03' 1.4915" S	110° 19' 36.6186" E	9,220,624.394	425,654.959	219.344	
JP - 19	7° 03' 34.4587" S	110° 20' 5.4294" E	9,219,613.256	426,540.306	218.583	
JP - 20	7° 04' 15.2827" S	110° 20' 28.5683" E	9,218,360.582	427,251.956	212.435	
BM - 13	6° 57' 52.1123" S	110° 24' 38.5192" E	9,230,137.634	434,905.154	0.349	

Table I.1.2 (1 / 3) Map Symbols













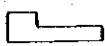


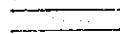

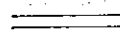

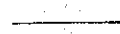

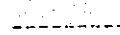

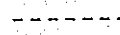

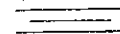

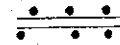

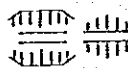

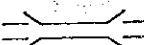

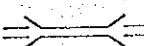
	Triangulation Point		Market
	GPS Point		Transformer house
	Bench Mark TTG		Bank
	Minor Order leveling		Gas station
	Spot elevation		Telephone office
	Minor order BM		Government office
	House/Building		Hotel
	Factory		Main road
	Public hall		Road >2m
	Public station		Road 1-2m
	Mosque		Road under construction
	Churc		Footpath
	Temple		Median strips
	Hospital		Road and strips
	Fire Station		Cutting and embankment
	Post Office		Iron and concrete bridge
	School		Wooden bridge

Table 1.1.2 (2 / 3) Map Symbols

	Foot bridge bamboo bridge		Cultivation land boundary
	Culvert		Rice field
	Railway		Farm/cultivated
	Railway bridge		Sugar cane
	Station		Palm plantation
	Intersecting railway		Rubber plantation
	Water/Oil Pipe		Teak plantation
	Water/Oil Tank		Coffee plantation
	Automatic waterlevel gauge		Cacao plantation
	Electricity power		Orchard
	Wall hedge/fence		Other plantation
	Monument		Bush
	Moslem graves		Grass field
	Christian cemetery		Trees/Forest
	Chinese graves		Dead trees
	Buddha graves		Bore land
	Vegetation boundary		Bamboo copse

Table 1.1.2 (3/3) Map Symbols


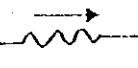


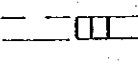
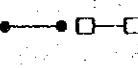

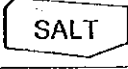
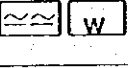
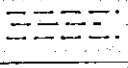

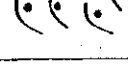
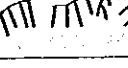
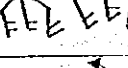
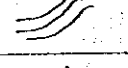

	River(a), rivulet(b), direction(c)	++ + ++ + ++ +	Kecamatan boundary
	Channel		
	Water fall		
	Small/large revetment		
	Small/large weir		
	Small/large watergate		
	Sand(a), shore line(b)		
	Saltarn		
	Fishpond/Pond, Lake		
	Swamp		
	Depression		
	Rocks		
	Precipice, Land slide		
	Cliff		
	Contour		
	Storages		
++ + ++ + ++ +	Kabupaten boundary		

Table I.1.3 Longitudinal Profile

Jatibarang Dam Site

LINE	DIS	ACCM.DIS	LEFT		CENTER		RIGHT		Total WIDTH	REMARKS
			Elevation	Δ width	Lowest	Width	Elevation	Δ width		
NO-3	-103.67	1086.85	69.24	29.24	67.90	19.98	69.71	37.25	86.47	
NO-2-200	-101.41	983.18			69.78					
NO-2-100	-102.06	881.77			69.72					
NO-2	-95.65	779.71	77.16	29.71	73.04	19.45	74.44	39.16	88.32	
NO-1-200	-97.69	684.06			74.98					
NO-1-100	-104.24	586.38			74.57					
NO-1	-89.95	482.13	87.72	30.99	75.46	24.57	83.23	43.19	98.75	
DAMLINE-400	-98.31	392.19			77.93					
DAMLINE-300	-83.68	293.88			81.76					
DAMLINE-200	-0.20	210.20			82.76					
DAMLINE-210(1)	-40.00	210.00			82.94					
DAMLINE-150(2)	-32.05	150.00			83.83					
DAMLINE-100	-27.95	117.95			85.39					
DAMLINE-90(3)	-30.00	90.00			85.85					
DAMLINE-60(4)	-30.00	60.00			86.52					
DAMLINE-30(5)	-30.00	30.00			87.57					
DAMLINE(6)	0.00	0.00	112.80	416.61	85.58	67.43	128.95	416.32	900.36	
DAMLINE+30(7)	30.00	30.00			87.64					
DAMLINE+60(8)	30.00	60.00			89.36					
NO0	100.00	100.00	128.44	345.88	90.32	81.99	136.19	431.66	859.53	
NO0+100	103.17	203.17			89.36					
NO0+200	87.32	290.49			94.78					
NO1	90.28	380.77	99.93	34.75	98.00	28.51	99.59	41.24	104.50	
NO1+100	84.19	464.96			98.35					
NO1+200	76.83	541.79			100.83					
NO2	94.81	636.60	105.58	36.95	103.03	11.96	108.65	40.90	89.81	
NO2+100	97.60	734.20			103.03					
NO2+200	112.06	846.25			108.55					
NO3	104.12	950.37	119.59	35.38	114.26	27.51	18.90	42.48	105.37	
NO3+100	101.22	1051.59			116.16					
NO3+200	101.65	1153.24			117.61					
NO4	84.00	1237.24	120.18	22.25	118.23	57.08	123.05	28.74	108.07	
NO4+100	86.46	1323.70			118.55					
NO4+168			R NO4+168M Small River / H = 119.91 W11.0 x H2.0							
NO4+200	82.23	1406.93			119.10					
NO5	85.65	1492.58	122.42	37.63	119.51	44.63	121.62	22.50	104.76	
NO5+100	116.17	1608.76			120.70					
NO5+200	103.83	1712.58			122.03					
NO6	103.92	1816.50	123.43	13.69	121.92	37.78	125.74	30.37	81.84	
NO6+100	94.18	1910.68			122.94					
NO6+200	106.80	2017.48			123.29					
NO7	90.89	2108.37	127.09	40.47	124.11	34.38	129.42	38.47	113.32	
NO7+100	98.28	2206.65			124.84					
NO7+200	98.56	2305.21			125.55					
NO8	97.23	2402.44	134.49	160.96	126.40	31.35	130.89	159.36	351.67	
NO8+100	100.99	2503.44			127.29					
NO8+200	93.69	2597.13			129.32					
NO9	111.43	2708.56	134.83	177.88	131.11	38.30	138.49	88.44	304.62	
NO9+100	79.16	2787.72			130.80					
NO9+200	101.25	2888.97			125.14					
NO10	89.81	2978.78	148.72	75.18	137.69	27.45	139.75	55.56	158.19	
NO10+100	96.01	3074.79			137.64					
NO10+200	71.57	3146.36			139.43					
NO11	86.02	3232.38	144.60	97.14	140.94	23.54	154.79	69.04	209.72	
NO11+100	90.09	3322.47			141.69					
NO11+200	101.42	3423.89			143.65					
NO12	82.15	3506.05	154.58	87.82	145.96	31.00	149.23	95.23	214.05	
NO12+100	50.25	3556.29			147.17					
NO12+200	113.31	3669.60			149.56					
NO13	95.63	3765.28	157.92	54.76	150.88	29.76	158.82	57.88	142.40	
NO13+100	102.14	3867.42			151.62					
NO13+200	103.23	3970.65			153.77					
NO14	96.54	4067.19	160.76	59.27	156.07	20.30	159.87	52.85	132.42	
NO14+100	82.37	4149.57			158.14					
NO14+200	92.79	4242.36			158.64					
NO15	102.81	4345.17	164.90	58.88	159.87	23.20	166.06	65.57	147.65	
NO15+100	102.97	4448.14			162.20					
NO15+200	111.41	4559.55			162.69					
NO16	102.69	4662.24	169.33	54.73	164.89	26.70	167.27	59.10	140.53	
NO16+100	99.53	4761.77			167.33					
NO16+200	94.06	4855.83			167.36					
NO17	107.26	4963.09	172.48	59.47	166.59	13.68	172.66	46.37	119.52	

6049.95

Table 2.1.1 Equipment For In-Situ Rock Shear Test

No.	EQUIPMENT	QUANTITY	CAPACITY	REMARK
1.	Oil Pressure Jack	1 unit	100 ton, stroke 200 mm	For vertical load
2.	Oil Pressure Jack (Separate Type)	1 unit	200 ton, stroke 75 mm	For shearing load
3.	Oil Pressure Pump (Separate Type)	1 unit	Max. pressure 800 kg/cm ²	For vertical load
4.	Oil Pressure Pump (Separate Type)	1 unit	Max. pressure 800 kg/cm ²	For shearing load
5.	Others (High-pressure hose, oil pressure gauge, etc).	1 lot	cm ²	
6.	Dial Gauge	10 units	1/100 mm, stroke 30 mm	
7.	Steel supporting for placing dial gauge.			
8.	Steel support for loading			

Table 2.2.1 (1/9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B-4	1	10.15 - 15.00	4.85	Upper Sedimentary Rock	CL - H	2.80	3.33	0.71	6.27	22.06
	2	15.15 - 20.00	4.85	Upper Sedimentary Rock	CL - H	4.29	3.85	0.76	7.50	21.28
	3	20.15 - 25.00	4.85	Upper Volcanic Breccia	CM - H	1.86	10.01	1.86	12.00	2.95
	4	25.15 - 30.00	4.85	Upper Volcanic Breccia	CM - H	0.75			12.06	1.28
	5	30.15 - 35.00	4.85	Middle Sedimentary Rock	CL - H	1.70	4.95	0.40	7.26	22.19
	6	35.15 - 40.00	4.85	Middle Sedimentary Rock	CL - H	3.93	8.57	3.16	12.14	8.87
	7	40.15 - 45.00	4.85	Middle Sedimentary Rock	CM - L	3.08	7.49	1.72	9.89	22.56
	8	45.15 - 50.00	4.85	Middle Sedimentary Rock	CL - H	1.95	7.55	1.08	11.75	15.09
	9	50.15 - 55.00	4.85	Middle Sedimentary Rock	CL - H	5.12	9.38	4.54	12.55	10.76
	10	55.15 - 60.00	4.85	Lower Volcanic Breccia	CM - H	0.08			13.51	0.32
	11	60.15 - 65.00	4.85	Lower Volcanic Breccia	CM - H	1.13			13.51	0.45
	12	65.15 - 70.00	4.85	Lower Volcanic Breccia	CM - H	6.27	9.19	5.44	12.41	9.94
	13	70.15 - 75.00	4.85	Lower Volcanic Breccia	CM - H	0.47			13.51	0.68
	14	75.15 - 80.00	4.85	Lower Volcanic Breccia	CM - H	0.85	9.52	0.81	13.49	1.79
	15	80.15 - 85.00	4.85	Lower Volcanic Breccia	CM - H	0.89			13.50	1.54
	16	85.15 - 90.00	4.85	Lower Volcanic Breccia	CM - H	1.34			13.47	1.89
	17	90.15 - 95.00	4.85	Lower Sedimentary Rock	D	3.43	6.49	1.65	11.21	12.29
B-5	1	10.15 - 15.00	4.85	Lower Volcanic Breccia	D	105.40			2.34	18.76
	2	15.15 - 20.00	4.85	Lower Volcanic Breccia	CM - H	5.50			10.06	5.53
	3	20.15 - 25.00	4.85	Lower Volcanic Breccia	CM - H	5.68			10.03	5.69
	4	25.15 - 30.00	4.85	Lower Volcanic Breccia	CM - H	5.73			10.00	5.73
	5	30.15 - 35.00	4.85	Lower Volcanic Breccia	CM - H	1.06			10.15	1.07
	6	35.15 - 40.00	4.85	Lower Volcanic Breccia	CM - H	1.30			10.15	1.32
	7	40.15 - 45.00	4.85	Lower Sedimentary Rock	D	71.31			1.63	20.87
	8	45.15 - 50.00	4.85	Lower Sedimentary Rock	CL - H	105.24			1.08	21.03
	9	50.15 - 55.00	4.85	Lower Sedimentary Rock	D	>100			-1.70	21.07
	10	55.15 - 60.00	4.85	Lower Sedimentary Rock	D	>100			-2.60	20.91
	11	60.15 - 65.00	4.85	Lower Sedimentary Rock	D		Spring (56 lt/min - 1.8 kg/cm ²)			
	12	65.15 - 70.00	4.85	Lower Sedimentary Rock	CL - L	>100			-1.86	14.10
	13	70.15 - 75.00	4.85	Lower Sedimentary Rock	CL - L	162.70			0.28	17.24
	14	75.15 - 80.00	4.85	Lower Sedimentary Rock	CL - L	1.35			10.14	1.36
	15	80.15 - 85.00	4.85	Lower Sedimentary Rock	D	32.49	4.23	11.59	4.57	15.96
	16	85.15 - 90.00	4.85	Lower Sedimentary Rock	CL - L	57.10			2.38	16.04
	17	90.15 - 95.00	4.85	Lower Sedimentary Rock	CL - L	71.91			4.49	15.79
	18	95.15 - 100.00	4.85	Lower Sedimentary Rock	D	19.03			5.00	10.50

Table 2.2.1 (2 / 9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B-6	1	8.15 - 10.00	1.85	Upper Sedimentary Rock	CL - H	22.72			5.87	13.15
	2	10.15 - 15.00	4.85	Upper Sedimentary Rock	CL - H	30.72	2.25	7.09	7.06	25.05
	3	15.15 - 20.00	4.85	Upper Sedimentary Rock	CL - L	12.93	6.49	8.45	9.34	21.65
	4	20.15 - 25.00	4.85	Upper Sedimentary Rock	CL - H	12.56	6.48	8.00	9.57	17.57
	5	25.15 - 30.00	4.85	Upper Sedimentary Rock	CL - L	8.44	7.20	5.94	10.49	13.81
	6	30.15 - 35.00	4.85	Upper Volcanic Breccia	CM - H	3.42			11.24	3.84
	7	35.15 - 40.00	4.85	Upper Volcanic Breccia	CM - H	3.10			11.24	3.51
	8	40.15 - 45.00	4.85	Middle Sedimentary Rock	CL - H	3.80	4.33	1.44	10.45	11.30
	9	45.15 - 50.00	4.85	Middle Sedimentary Rock	CL - H	6.92			10.93	7.59
	10	50.15 - 55.00	4.85	Middle Sedimentary Rock	CL - H	4.60			13.46	6.93
	11	55.15 - 60.00	4.85	Middle Sedimentary Rock	CL - H	5.33			13.31	7.67
	12	60.15 - 65.00	4.85	Middle Sedimentary Rock	CL - L	9.51	9.21	8.45	10.16	19.18
	13	65.15 - 70.00	4.85	Middle Sedimentary Rock	CL - L	8.65	9.18	7.63	11.23	15.30
	14	70.15 - 75.00	4.85	Lower Volcanic Breccia	CM - H	9.44	8.17	7.26	10.31	14.43
	15	75.15 - 80.00	4.85	Lower Volcanic Breccia	CM - H	4.09			13.44	6.19
	16	80.15 - 85.00	4.85	Lower Volcanic Breccia	CM - H	4.11			12.59	5.48
	17	85.15 - 90.00	4.85	Lower Volcanic Breccia	CM - H	2.55			12.99	3.63
	18	90.15 - 95.00	4.85	Lower Volcanic Breccia	CM - H	2.73			12.80	3.88
	19	95.15 - 100.00	4.85	Lower Volcanic Breccia	CM - H	1.24			12.95	1.72
	20	100.2 - 105.00	4.85	Lower Sedimentary Rock	CL - L	4.08			12.53	5.44
	21	105.2 - 110.00	4.85	Lower Sedimentary Rock	CL - L	4.48			13.08	6.39
	22	110.2 - 115.00	4.85	Lower Sedimentary Rock	CL - L	12.36	5.59	3.92	7.08	19.13
	23	115.2 - 120.00	4.85	Lower Sedimentary Rock	CL - L	14.79	4.05	5.98	-3.76	20.51
	24	120.2 - 125.00	4.85	Lower Sedimentary Rock	CL - L	0.86	7.40	0.46	12.16	7.84
B-7	1	5.00 - 10.00	5.00	Middle Sedimentary Rock	CL - L	55.78			2.52	20.44
	2	10.00 - 15.00	5.00	Lower Volcanic Breccia	CM - H	3.61	3.19	1.56	9.98	9.36
	3	15.00 - 20.00	5.00	Lower Volcanic Breccia	CM - H	4.57	4.19	2.16	10.04	7.04
	4	20.45 - 25.00	4.55	Lower Volcanic Breccia	CM - H	3.30			10.18	3.38
	5	25.00 - 30.00	5.00	Lower Volcanic Breccia	CM - H	2.52			10.19	2.57
	6	30.00 - 35.00	5.00	Lower Volcanic Breccia	CM - H	1.80			9.20	1.63
	7	35.00 - 40.00	5.00	Lower Volcanic Breccia	CM - H	2.10	4.19	0.81	10.12	3.20
	8	40.00 - 45.00	5.00	Lower Sedimentary Rock	D	176.50	0.55	19.76	0.55	19.76
	9	45.00 - 50.00	5.00	Lower Sedimentary Rock	CL - H	29.13	2.91	13.92	3.06	20.20
	10	50.00 - 55.00	5.00	Lower Sedimentary Rock	CL - L	35.29			5.62	17.04
	11	55.00 - 60.00	5.00	Lower Sedimentary Rock	CL - L	45.33			3.59	19.60
	12	60.00 - 65.00	5.00	Lower Sedimentary Rock	CL - L	36.72	2.01	14.52	2.16	19.36
	13	65.00 - 70.00	5.00	Lower Sedimentary Rock	CL - L	48.99			1.48	13.80

Table 2.2.1 (3 / 9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classificatio	Lugeon Value	Critical Point		Maximum Point	
							P	Qt	P	Qt
B-8	1	5.00 - 10.00	5.00	Middle Sedimentary Rock	CL - L	47.90	1.61	8.40	1.90	14.04
	2	10.00 - 15.00	5.00	Lower Volcanic Rock	CM - H	9.20	5.16	5.20	9.92	11.08
	3	15.00 - 20.00	5.00	Lower Volcanic Rock	CM - H	11.80			9.77	11.52
	4	20.00 - 25.00	5.00	Lower Volcanic Rock	CM - H	6.07			10.07	6.12
	5	25.00 - 30.00	5.00	Lower Volcanic Rock	CM - H	2.50	3.23	0.88	10.09	5.28
	6	30.00 - 35.00	5.00	Lower Volcanic Rock	CM - H	1.70	3.23	0.64	10.11	4.48
	7	35.00 - 40.00	5.00	Lower Volcanic Rock	CM - H	1.40			10.22	1.47
	8	40.00 - 45.00	5.00	Lower Volcanic Rock	CM - H	58.90			2.94	14.68
	9	45.00 - 50.00	5.00	Lower Sedimentary Rock	D	67.60	0.48	10.55	0.07	15.71
	10	50.00 - 55.00	5.00	Lower Sedimentary Rock	CL - L	65.10			5.24	19.07
	11	55.00 - 60.00	5.00	Lower Sedimentary Rock	D	25.79			5.90	15.40
	12	60.00 - 65.00	5.00	Lower Sedimentary Rock	CL - L	17.90			6.27	13.64
	13	65.00 - 70.00	5.00	Lower Sedimentary Rock	CL - L	21.01	2.66	5.92	5.76	18.92
B-9	1	16.10 - 20.00	3.90	Upper Sedimentary Rock	CL - H	17.06	7.51	13.44	10.97	21.28
	2	20.10 - 25.00	4.90	Upper Sedimentary Rock	CL - H	11.14	8.00	8.94	11.49	14.49
	3	25.10 - 30.00	4.90	Upper Sedimentary Rock	CL - H	7.13			12.39	9.43
	4	30.10 - 35.00	4.90	Upper Sedimentary Rock	CL - H	7.96	5.02	3.14	8.71	20.61
	5	35.10 - 40.00	4.90	Upper Sedimentary Rock	CL - H	6.89	6.71	3.43	12.11	16.20
	6	40.10 - 45.00	4.90	Upper Sedimentary Rock	CL - H	15.75	6.82	8.24	9.23	20.61
	7	45.10 - 50.00	4.90	Upper Sedimentary Rock	CL - H	13.91	6.63	2.04	13.40	11.92
	8	50.10 - 55.00	4.90	Upper Volcanic Breccia	CM - H	4.57	7.22	7.35	10.25	20.53
	9	55.10 - 60.00	4.90	Upper Volcanic Breccia	CM - H	2.44	6.72	1.22	13.81	9.71
	10	60.10 - 65.00	4.90	Upper Volcanic Breccia	CM - H	2.90			14.37	5.47
	11	65.10 - 70.00	4.90	Upper Volcanic Breccia	CL - H	2.96			14.48	5.92
	12	70.10 - 75.00	4.90	Middle Sedimentary Rock	CM - L	1.37	8.89	1.00	13.88	11.38
	13	75.10 - 80.00	4.90	Middle Sedimentary Rock	CM - L	0.49	12.97	0.86	13.59	10.29
	14	80.10 - 85.00	4.90	Middle Sedimentary Rock	CL - H	0.33	7.96	0.31	13.64	9.71
	15	85.10 - 90.00	4.90	Lower Volcanic Breccia	CL - L	2.54	8.90	1.93	12.93	11.71

Table 2.2.1 (4 / 9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B-10	1	11.10 - 15.00	3.90	Upper Sedimentary Rock	CM - L	2.90	4.30	1.10	8.53	23.64
	2	15.10 - 20.00	4.90	Upper Sedimentary Rock	CL - H	4.76			11.34	5.43
	3	20.10 - 25.00	4.90	Upper Sedimentary Rock	CL - L	5.36			9.89	5.43
	4	25.10 - 30.00	4.90	Upper Sedimentary Rock	CL - H	16.95	3.59	6.08	6.92	19.96
	5	30.10 - 35.00	4.90	Upper Sedimentary Rock	CL - L	15.21	3.60	5.47	6.44	20.57
	6	35.10 - 40.00	4.90	Upper Sedimentary Rock	CM - L	4.80	4.42	2.12	6.61	21.22
	7	40.10 - 45.00	4.90	Upper Sedimentary Rock	CM - L	9.10	6.95	5.10	9.36	19.71
	8	45.10 - 50.00	4.90	Upper Sedimentary Rock	CL - H	20.81	5.65	11.76	8.98	21.71
	9	50.10 - 55.00	4.90	Upper Sedimentary Rock	CL - L	9.36	5.97	5.59	9.41	20.86
	10	55.10 - 60.00	4.90	Upper Sedimentary Rock	CL - H	6.52	11.22	7.59	12.55	11.27
	11	60.10 - 65.00	4.90	Upper Volcanic Breccia	CM - H	4.65			13.47	6.90
	12	65.10 - 70.00	4.90	Upper Volcanic Breccia	CM - H	2.31			15.27	4.69
	13	70.10 - 75.00	4.90	Upper Volcanic Breccia	CM - H	1.75			15.41	3.27
	14	75.10 - 80.00	4.90	Middle Sedimentary Rock	CL - H	7.42	7.16	5.92	12.16	16.29
	15	80.10 - 85.00	4.90	Middle Sedimentary Rock	CM - L	1.68			15.40	2.44
	16	85.10 - 90.00	4.90	Middle Sedimentary Rock	CM - L	3.56	8.72	3.16	15.55	9.26
B-11	1	17.00 - 20.00	3.00	Upper Sedimentary Rock	CL - H	4.80	7.98	3.60	9.85	10.87
	2	20.00 - 25.00	5.00	Upper Sedimentary Rock	CL - H	4.20	5.38	2.20	7.70	20.12
	3	24.50 - 30.00	5.00	Upper Sedimentary Rock	CL - H	5.60	6.85	2.16	11.92	12.55
	4	30.00 - 35.00	5.00	Upper Sedimentary Rock	CL - H	3.50	6.38	1.64	12.36	13.20
	5	35.00 - 40.00	5.00	Upper Sedimentary Rock	CL - L	2.90	6.90	1.65	12.63	13.64
	6	40.00 - 45.00	5.00	Upper Sedimentary Rock	CM - L	1.20	6.91	0.50	13.77	4.28
	7	45.00 - 50.00	5.00	Upper Sedimentary Rock	CL - H	1.80	6.91	0.85	13.45	7.36
	8	50.00 - 55.00	5.00	Upper Sedimentary Rock	CL - H	2.80	6.56	1.29	13.18	6.48
	9	55.00 - 60.00	5.00	Upper Sedimentary Rock	CL - H	4.30	5.56	1.33	12.25	11.36
	10	60.00 - 65.00	5.00	Upper Volcanic Breccia	CM - H	1.80			13.49	2.90
	11	65.00 - 70.00	5.00	Upper Volcanic Breccia	CM - H	3.30			13.25	5.16
	12	70.00 - 75.00	5.00	Upper Volcanic Breccia	CM - H	3.60			13.23	5.72
	13	75.00 - 80.00	5.00	Middle Sedimentary Rock	CL - H	2.30	6.64	1.07	12.98	7.00
	14	80.00 - 85.00	5.00	Middle Sedimentary Rock	CL - H	3.60			12.99	7.48
	15	85.00 - 90.00	5.00	Middle Sedimentary Rock	CL - H	5.60			12.74	8.24
	16	90.00 - 95.00	5.00	Lower Volcanic Breccia	CM - H	6.18	9.36	5.68	11.90	11.00
	17	95.00 - 100.00	5.00	Lower Volcanic Breccia	CM - H	2.50			13.70	3.90

Table 2.2.1 (5 / 9) Summary of Lugeon Test (Dam Site Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B - 12	1	5.10 - 10.00	4.90	Upper Sedimentary Rock	CM - L	26.40	1.72	4.55	3.07	23.22
	2	10.10 - 15.00	4.90	Upper Sedimentary Rock	CL - H	36.29	2.78	15.43	4.01	24.33
	3	15.10 - 20.00	4.90	Upper Sedimentary Rock	CL - H	76.42			3.05	25.10
	4	20.10 - 25.00	4.90	Upper Sedimentary Rock	CL - L	35.88	3.29	15.24	3.91	24.00
	5	25.10 - 30.00	4.90	Upper Volcanic Breccia	CM - H	6.30	6.18	3.22	11.50	12.37
	6	30.10 - 35.00	4.90	Middle Sedimentary Rock	CL - H	7.07	6.18	3.76	11.40	12.45
	7	35.10 - 40.00	4.90	Middle Sedimentary Rock	CL - H	3.30	5.65	1.51	11.92	10.73
	8	40.10 - 45.00	4.90	Middle Sedimentary Rock	CL - H	3.81	6.61	1.92	12.83	10.57
	9	45.10 - 50.00	4.90	Middle Sedimentary Rock	CL - H	7.57	5.79	5.96	11.57	13.67
	10	50.10 - 55.00	4.90	Middle Sedimentary Rock	CL - L	14.12			10.98	16.00
	11	55.10 - 60.00	4.90	Lower Volcanic Breccia	CM - H	2.54			13.35	3.63
	12	60.10 - 65.00	4.90	Lower Volcanic Breccia	CM - H	2.56			13.45	3.67
	13	65.10 - 70.00	4.90	Lower Volcanic Breccia	CM - H	5.18			13.01	7.27
	14	70.10 - 75.00	4.90	Lower Volcanic Breccia	CM - H	1.03			13.64	1.58
	15	75.10 - 80.00	4.90	Lower Volcanic Breccia	CM - H	0.11			13.67	0.19
B - 13	1	11.10 - 15.00	3.90	Upper Sedimentary Rock	CL - H	130.84	1.40	25.49	1.40	25.49
	2	15.10 - 20.00	4.90	Upper Sedimentary Rock	CL - H	52.30			3.48	20.78
	3	20.10 - 25.00	4.90	Upper Sedimentary Rock	CL - H	2.38	5.05	1.27	10.98	16.90
	4	25.10 - 30.00	4.90	Upper Sedimentary Rock	CL - H	3.58	5.75	1.77	11.05	13.13
	5	30.10 - 35.00	4.90	Upper Volcanic Breccia	CM - H	3.52	4.31	1.18	11.61	11.43
	6	35.10 - 40.00	4.90	Upper Volcanic Breccia	CM - H	4.09	5.80	1.59	12.06	10.98
	7	40.10 - 45.00	4.90	Upper Volcanic Breccia	CM - H	3.78	5.79	1.88	11.78	12.08
	8	45.10 - 50.00	4.90	Middle Sedimentary Rock	CL - H	8.26			12.12	10.37
	9	50.10 - 55.00	4.90	Middle Sedimentary Rock	CL - H	9.27			11.94	11.35
	10	55.10 - 60.00	4.90	Middle Sedimentary Rock	CL - H	7.52			11.93	10.82
	11	60.10 - 65.00	4.90	Middle Sedimentary Rock	CL - H	7.30			11.81	11.18
	12	65.10 - 70.00	4.90	Lower Volcanic Breccia	CM - H	8.03			11.66	11.35
	13	70.10 - 75.00	4.90	Lower Volcanic Breccia	CM - H	0.29			13.17	0.45
	14	75.10 - 80.00	4.90	Lower Volcanic Breccia	CM - H	1.59	7.17	0.84	12.91	4.50

Table 2.2.1 (6/9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B-14	1	30.10 - 35.00	4.90	Upper Sedimentary Rock	CL - H	2.20	9.34	1.95	13.19	5.67
	2	35.10 - 40.00	4.90	Upper Sedimentary Rock	D	1.85	9.79	1.78	13.34	8.61
	3	40.10 - 45.00	4.90	Upper Sedimentary Rock	CL - L	0.82	10.07	0.83	13.98	3.49
	4	45.10 - 50.00	4.90	Upper Sedimentary Rock	CL - L	0.94	6.52	0.38	13.27	12.45
	5	50.10 - 55.00	4.90	Upper Sedimentary Rock	CL - L	1.44	7.24	0.51	13.69	13.18
	6	55.10 - 60.00	4.90	Upper Sedimentary Rock	CL - L	1.34	9.71	1.25	13.85	13.88
	7	60.10 - 65.00	4.90	Upper Sedimentary Rock	CL - L	0.41	8.09	0.36	15.58	6.94
	8	65.10 - 70.00	4.90	Upper Sedimentary Rock	CL - H	0.95	11.09	1.28	15.41	5.16
	9	70.10 - 75.00	4.90	Upper Sedimentary Rock	D	7.66	7.20	5.51	14.26	13.71
	10	75.10 - 80.00	4.90	Upper Sedimentary Rock	CL - L	1.21			13.78	3.27
	11	80.10 - 85.00	4.90	Upper Volcanic Breccia	CM - H	0.52			15.91	1.05
B-15	1	15.00 - 20.00	5.00	Upper Sedimentary Rock	CM - L	2.05	4.90	1.44	11.65	8.88
	2	20.00 - 25.00	5.00	Upper Sedimentary Rock	CL - H	6.06			12.17	7.56
	3	25.00 - 30.00	5.00	Upper Sedimentary Rock	CL - H	6.10			12.49	7.80
	4	30.00 - 35.00	5.00	Upper Sedimentary Rock	CL - L	4.91			11.57	6.04
	5	35.00 - 40.00	5.00	Upper Sedimentary Rock	CM - L	4.87			11.37	5.76
	6	40.00 - 45.00	5.00	Upper Sedimentary Rock	CL - H	1.05	6.59	0.62	11.34	5.71
	7	45.00 - 50.00	5.00	Upper Sedimentary Rock	CL - H	2.11	8.85	1.77	11.66	5.02
	8	50.00 - 55.00	5.00	Upper Sedimentary Rock	CM - L	2.30	8.80	1.92	12.59	5.08
	9	55.00 - 60.00	5.00	Upper Sedimentary Rock	CL - H	1.90	6.74	1.35	12.34	6.41
B-18	1	12.10 - 15.00	2.90	Upper Sedimentary Rock	CL - H	2.14	4.41	0.85	10.52	33.38
	2	15.10 - 20.00	4.90	Upper Volcanic Breccia	CM - L	1.02			10.51	1.07
	3	20.10 - 25.00	4.90	Upper Volcanic Breccia	CM - L	1.29			11.55	1.51
	4	25.10 - 30.00	4.90	Middle Sedimentary Rock	CM - L	1.09			11.60	1.29
	5	30.10 - 35.00	4.90	Middle Sedimentary Rock	CL - H	0.91	7.78	0.70	11.49	7.35
	6	35.10 - 40.00	4.90	Middle Sedimentary Rock	CL - H	1.20	9.83	1.18	10.82	1.86
	7	40.10 - 45.00	4.90	Middle Sedimentary Rock	CL - H	1.38	7.89	1.04	11.63	6.12
	8	45.10 - 50.00	4.90	Middle Sedimentary Rock	CL - H	1.09	5.94	0.46	10.82	11.84
	9	50.10 - 55.00	4.90	Lower Volcanic Breccia	CL - H	2.65			12.18	3.33
	10	55.10 - 60.00	4.90	Lower Volcanic Breccia	CM - L	2.56			12.08	3.18
	11	60.10 - 65.00	4.90	Lower Volcanic Breccia	CM - H	0.63	10.21	0.65	12.18	1.75
	12	65.10 - 70.00	4.90	Lower Volcanic Breccia	CM - H	0.63			12.01	0.80
	13	70.10 - 75.00	4.90	Lower Volcanic Breccia	CM - H	0.37	7.99	0.27	11.88	3.08
	14	75.10 - 80.00	4.90	Lower Volcanic Breccia	CM - H	0.10	10.00	0.10	11.99	0.94

Table 2.2.1 (7/9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B - 19	1	10.00 - 15.00	5.00	Upper Sedimentary Rock	CM - L	32.03			4.87	15.08
	2	15.00 - 20.00	5.00	Upper Sedimentary Rock	CL - H	75.64			2.54	20.32
	3	20.00 - 25.00	5.00	Upper Sedimentary Rock	CM - L	14.77	4.28	6.32	6.71	13.12
	4	25.00 - 30.00	5.00	Upper Sedimentary Rock	CL - H	2.50	4.21	1.01	11.30	13.32
	5	30.00 - 35.00	5.00	Upper Volcanic Breccia	CM - H	9.35			10.89	10.37
	6	35.00 - 40.00	5.00	Upper Volcanic Breccia	CM - H	34.63	2.13	7.36	1.81	19.72
	7	40.00 - 45.00	5.00	Middle Sedimentary Rock	CL - H	58.63	3.02	17.68	2.57	22.32
	8	45.00 - 50.00	5.00	Middle Sedimentary Rock	CL - H	7.51			13.57	12.44
	9	50.00 - 55.00	5.00	Middle Sedimentary Rock	CL - H	9.09			13.05	14.00
	10	55.00 - 60.00	5.00	Middle Sedimentary Rock	CL - H	13.89	8.12	11.08	9.76	23.28
	11	60.00 - 65.00	5.00	Lower Volcanic Breccia	CL - H	17.53	6.64	7.60	9.86	18.33
	12	65.00 - 70.00	5.00	Lower Volcanic Breccia	CM - H	0.47			15.43	0.88
	13	70.00 - 75.00	5.00	Lower Volcanic Breccia	CM - H	1.64			15.47	2.65
	14	75.00 - 80.00	5.00	Lower Volcanic Breccia	CM - H	1.04			15.01	1.60
B - 20	1	12.60 - 15.00	2.40	Upper Sedimentary Rock	CL - L	49.34	4.09	24.42	6.42	41.63
	2	15.60 - 20.00	4.40	Upper Sedimentary Rock	CL - L	5.05	3.83	1.95	9.16	16.52
	3	21.60 - 25.00	3.40	Upper Volcanic Breccia	CM - L	1.36	3.95	0.26	4.68	11.71
	4	25.10 - 30.00	4.90	Upper Volcanic Breccia	CM - H	3.12	5.95	1.63	10.93	14.73
	5	30.10 - 35.00	4.90	Upper Volcanic Breccia	CL - H	1.93	4.96	0.55	10.78	14.57
	6	35.10 - 40.00	4.90	Middle Sedimentary Rock	CL - H	3.06	5.95	1.38	10.60	14.57
	7	40.10 - 45.00	4.90	Middle Sedimentary Rock	CM - H	2.46	5.97	1.22	11.55	7.67
	8	45.10 - 50.00	4.90	Middle Sedimentary Rock	CL - L	2.04	9.99	2.04	11.83	4.94
	9	50.10 - 55.00	4.90	Middle Sedimentary Rock	CM - H	1.40	5.12	0.46	11.23	9.96
	10	55.10 - 60.00	4.90	Lower Volcanic Breccia	CM - H	3.00	10.49	3.20	12.39	4.53
	11	60.10 - 65.00	4.90	Lower Volcanic Breccia	CM - H	0.52			12.64	0.65
	12	65.10 - 70.00	4.90	Lower Volcanic Breccia	CM - H	0.69			12.64	0.91
	13	70.10 - 75.00	4.90	Lower Volcanic Breccia	CM - H	2.06	6.62	1.39	11.59	6.28
	14	75.10 - 80.00	4.90	Lower Volcanic Breccia	CM - H	0.02			12.66	0.00
B - 21	1	5.00 - 15.00	10.00	Lower Volcanic Breccia	CM - H	12.30			7.45	9.40
	2	10.00 - 15.00	5.00	Lower Volcanic Breccia	CM - H	7.80			10.03	7.84
	3	15.00 - 20.00	5.00	Lower Volcanic Breccia	CM - H	1.19	3.18	0.64	9.12	4.12
B - 22	1	5.00 - 10.00	5.00	Lower Volcanic Breccia	CM - H	27.40	2.10	6.60	4.44	21.28
	2	10.00 - 15.00	5.00	Lower Volcanic Breccia	CM - H	2.70			10.13	3.76
	3	15.00 - 20.00	5.00	Lower Volcanic Breccia	CM - H	7.90			9.96	7.88

Table 2.2.1 (8/9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B-27	1	11.10 - 15.00	3.90	Upper Sedimentary Rock	CL - H	185.04			1.68	25.23
	2	15.10 - 20.00	4.90	Upper Volcanic Breccia	CM - H	2.69	2.90	0.49	10.45	10.78
	3	20.10 - 25.00	4.90	Upper Volcanic Breccia	CM - H	1.23	8.38	0.97	9.65	13.76
	4	25.10 - 30.00	4.90	Middle Sedimentary Rock	CL - H	3.41	6.33	1.71	9.85	10.20
	5	30.10 - 35.00	4.90	Middle Sedimentary Rock	CL - H	1.31	4.19	0.55	4.56	21.71
	6	35.10 - 40.00	4.90	Middle Sedimentary Rock	CM - L	2.22	11.05	2.57	12.78	6.91
	7	40.10 - 45.00	4.90	Middle Sedimentary Rock	CM - L	2.15	9.79	2.07	10.52	17.84
	8	45.10 - 50.00	4.90	Middle Sedimentary Rock	CL - H	1.15	7.97	0.72	11.43	17.71
	9	50.10 - 55.00	4.90	Lower Volcanic Breccia	CM - H	0.32	7.26	0.21	12.38	14.49
	10	55.10 - 60.00	4.90	Lower Volcanic Breccia	CM - H	1.87	10.24	1.95	13.80	8.62
	11	60.10 - 65.00	4.90	Lower Volcanic Breccia	CM - H	3.34	7.38	2.37	13.60	8.86
	12	65.10 - 70.00	4.90	Lower Volcanic Breccia	CM - H	0.25	10.26	0.25	14.01	4.69
	13	70.10 - 75.00	4.90	Lower Volcanic Breccia	CM - H	0.35			14.30	0.61
	14	75.10 - 80.00	4.90	Lower Volcanic Breccia	CM - H	0.59			14.28	0.90
	15	80.10 - 85.00	4.90	Lower Volcanic Breccia	CM - H	0.82			14.23	1.47
B-28	1	5.00 - 10.00	5.00	Upper Pyroclastic Rock	CL - H	26.370			6.55	13.56
	2	10.00 - 15.00	5.00	Upper Pyroclastic Rock	CM - H	2.480	4.30	1.00	11.26	4.48
	3	15.00 - 20.00	5.00	Upper Pyroclastic Rock	CM - H	4.790	4.49	1.47	11.00	12.52
	4	20.00 - 25.00	5.00	Upper Pyroclastic Rock	CM - H	5.120	5.57	2.80	11.18	10.24
	5	25.00 - 30.00	5.00	Middle Sedimentary Rock	CL - H	12.550	3.74	4.38	10.33	17.52
	6	30.00 - 35.00	5.00	Middle Sedimentary Rock	CL - H	2.870	5.75	1.40	11.40	7.88
	7	35.00 - 40.00	5.00	Middle Sedimentary Rock	CL - H	4.150	6.45	2.57	12.11	7.62
	8	40.00 - 45.00	5.00	Middle Sedimentary Rock	CL - H	3.100	5.39	1.09	12.08	6.51
	9	45.00 - 50.00	5.00	Lower Pyroclastic Rock	CM - H	5.200	4.38	1.32	11.95	7.32
	10	50.00 - 55.00	5.00	Lower Pyroclastic Rock	CM - H	0.100			12.39	0.77
	11	55.00 - 60.00	5.00	Lower Pyroclastic Rock	CM - H	8.330			11.77	8.85
	12	60.00 - 65.00	5.00	Lower Pyroclastic Rock	CM - H	1.050	6.57	0.56	12.53	1.94
	13	65.00 - 70.00	5.00	Lower Pyroclastic Rock	CM - H	0.004	10.58	0.35	12.52	2.30
	14	70.00 - 75.00	5.00	Lower Pyroclastic Rock	CM - H	1.724			12.30	2.31
	15	75.00 - 80.00	5.00	Lower Pyroclastic Rock	CM - H	1.559			12.55	1.90
	16	80.00 - 85.00	5.00	Lower Sedimentary Rock	CL - L	>100			5.48	10.12
	17	85.00 - 90.00	5.00	Lower Sedimentary Rock	CL - L	5.974	5.32	4.87	11.30	9.14
	18	90.00 - 100.00	5.00	Lower Sedimentary Rock	CL - L	>100			2.78	6.84
	19	100.00 - 105.00	5.00	Lower Sedimentary Rock	CL - L	0.480	6.54	0.44	9.94	6.85

Table 2.2.1 (9/9) Summary of Lugeon Test (Damsite Area)

Hole No.	Stage Number	Section of Test (M)	Length Stage (M)	Geological Unit	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
							P	Qu	P	Qu
B-29	1	5.00 - 10.00	5.00	Lower Pyroclastic Rock	CM - L	41.533			6.52	20.00
	2	10.00 - 15.00	5.00	Lower Pyroclastic Rock	CL - H	3.989	8.07	3.32	9.97	7.56
	3	15.00 - 20.00	5.00	Lower Pyroclastic Rock	CL - H	17.400			9.53	13.40
	4	20.00 - 25.00	5.00	Lower Pyroclastic Rock	CM - H	12.271			9.79	8.28
	5	25.00 - 30.00	5.00	Lower Pyroclastic Rock	CM - H	0.267	8.07	0.21	10.06	1.20
	6	30.00 - 35.00	5.00	Lower Pyroclastic Rock	CM - H	4.093			10.01	3.14
	7	35.00 - 40.00	5.00	Lower Pyroclastic Rock	CM - H	1.190			10.06	1.00
	8	40.00 - 45.00	5.00	Lower Sedimentary Rock	CL - H	41.588			7.69	17.76
	9	67.00 - 70.00	5.00	Lower Sedimentary Rock	CL - L	3.548	6.05	2.07	9.83	7.43
	10	70.00 - 75.00	5.00	Lower Sedimentary Rock	CL - L	0.089	3.07	0.02	3.61	5.98
	11	76.00 - 80.00	4.00	Lower Sedimentary Rock	CL - L	11.274			9.78	5.72
B-30	1	5.00 - 10.00	5.00	Upper Sedimentary Rock	CL - L	8.257	2.81	3.19	9.98	24.24
	2	10.00 - 15.00	5.00	Upper Sedimentary Rock	CL - H	6.677	4.31	2.15	10.14	22.60
	3	15.00 - 20.00	5.00	Upper Pyroclastic Rock	CL - H	7.318	4.31	2.16	8.48	16.28
	4	20.00 - 25.00	5.00	Upper Pyroclastic Rock	CL - H	7.591	5.23	2.60	9.70	25.12
	5	25.00 - 30.00	5.00	Upper Pyroclastic Rock	CL - H	2.413	2.91	0.62	8.53	21.96
	6	30.00 - 35.00	5.00	Middle Sedimentary Rock	CM - L	18.004	5.25	3.40	8.51	22.00
	7	35.00 - 40.00	5.00	Middle Sedimentary Rock	CL - H	4.145	6.39	1.96	7.71	16.00
	8	40.00 - 45.00	5.00	Middle Sedimentary Rock	CL - H	4.482	7.99	3.34	7.99	3.34
	9	45.00 - 50.00	5.00	Middle Sedimentary Rock	CL - H	5.992	8.24	4.46	8.24	4.60
	10	50.00 - 55.00	5.00	Lower Pyroclastic Rock	CL - H	6.936			13.29	10.84
	11	55.00 - 60.00	5.00	Lower Pyroclastic Rock	CM - H	0.801	10.80	0.90	12.75	2.38
	12	60.00 - 65.00	5.00	Lower Pyroclastic Rock	CL - L	4.274	5.75	2.14	10.79	9.56
	13	65.00 - 70.00	5.00	Lower Pyroclastic Rock	CM - L	3.164	9.86	3.09	13.44	6.66
	14	70.00 - 75.00	5.00	Lower Pyroclastic Rock	CM - H	0.313	9.97	0.31	13.93	1.67
	15	75.00 - 80.00	5.00	Lower Pyroclastic Rock	CM - H	0.632	10.23	0.66	14.20	1.78
	16	80.00 - 85.00	5.00	Lower Pyroclastic Rock	CM - H	1.163			9.90	1.52
	17	85.00 - 90.00	5.00	Lower Pyroclastic Rock	CM - H	0.862			8.87	0.52
	18	92.00 - 95.00	5.00	Lower Sedimentary Rock	CM - L	1.690			7.47	1.06
	19	95.00 - 100.00	5.00	Lower Sedimentary Rock	CL - H	0.575	6.68	0.28	9.66	1.14
	20	100.00 - 105.00	5.00	Lower Sedimentary Rock	CL - L	0.636			11.67	0.80
	21	115.00 - 120.00	5.00	Lower Sedimentary Rock	CL - L	1.767	7.37	1.30	9.21	3.00
	22	115.00 - 125.00	10.00	Lower Sedimentary Rock	CL - L	18.872	4.10	1.30	4.10	1.30

Table 2.2.2 Result of Shearing Test

Adit	No.	Initial Vertical Load P (ton)	Maximum Shear Load S (ton)	Vertical Stress $(P+S*\sin 15^\circ)/A$ (t/m ²)	Shear Strength $S*\cos 15^\circ/A$ (t/m ²)
Block Shear Test (Shear Area A=0.6m*0.6m)					
T - 1 (EL. 93 m)	T1 - 1	20.0	38.0	82.9	102.0
	T1 - 2	10.0	26.0	46.5	69.8
	T1 - 3	20.0	29.0	76.4	77.8
	T1 - 4	10.0	25.0	45.8	67.1
T - 3 (EL. 140 m)	T3 - 1	10.0	18.0	40.7	48.3
	T3 - 2	20.0	27.0	75.0	72.5
	T3 - 3	20.0	42.0	85.8	112.7
	T3 - 4	10.0	33.0	51.5	88.6
Rock Shear Test (Shear Area A=0.4m*0.4m)					
T - 1 (EL. 93 m)	T1 - 1	12.0	46.0	149.5	277.7
	T1 - 2	6.0	24.0	76.4	144.9
	T1 - 3	6.0	15.0	61.8	90.6
	T1 - 4	12.0	18.0	104.1	108.7

Table 2.2.3 Elastic Modulus By Loading Test

Adit	No.	Vertical Load P (ton)	Displacement W (0.01 mm)	Elastic Modulus Ei (kg/cm ²)
T-1 (EL 93 mm)	T1-1	24-12 = 12	1.5 - 0.0 = 1.5	E ₁ = 110,000
		22-18 = 4	1.0 - 0.8 = 0.2	E ₂ = 280,000
		24-0 = 24	1.5 - 0.0 = 1.5	E ₃ = 220,000
	T1-2	24-18 = 6	0.8 - 0.0 = 0.8	E ₁ = 100,000
		22-20 = 2	0.8 - 0.3 = 0.5	E ₂ = 55,000
		24-0 = 24	0.8 - 0.0 = 0.8	E ₃ = 410,000
	T1-3	16-4 = 12	36.5 - 6.8 = 29.7	E ₁ = 5,600
		14-10 = 4	32.0 - 23.3 = 8.7	E ₂ = 6,300
		16-0 = 16	36.5 - 16.3 = 20.2	E ₃ = 11,000
	T1-4	16-6 = 10	14.3 - 2.8 = 11.5	E ₁ = 12,000
		10-8 = 2	7.8 - 6.0 = 1.8	E ₂ = 15,000
		16-0 = 16	14.3 - 4.0 = 10.3	E ₃ = 21,000
T-3 (EL 140 mm)	T3-1	14-4 = 10	101.3 - 19.3 = 82.0	E ₁ = 1,700
		8-4 = 4	53.8 - 39.8 = 14.0	E ₂ = 3,900
		14-0 = 14	101.3 - 36.5 = 64.8	E ₃ = 3,000
	T3-2	16-6 = 10	31.3 - 3.3 = 28.0	E ₁ = 4,900
		12-6 = 6	18.0 - 8.7 = 9.3	E ₂ = 8,900
		16-0 = 16	31.3 - 7.0 = 24.3	E ₃ = 9,100
	T3-3	16-4 = 12	22.8 - 4.0 = 18.8	E ₁ = 8,800
		10-6 = 4	14.8 - 8.8 = 6.0	E ₂ = 9,200
		16-0 = 16	22.8 - 4.0 = 18.8	E ₃ = 12,000
	T3-4	16-4 = 12	22.8 - 5.8 = 17.0	E ₁ = 9,700
		6-2 = 4	8.8 - 6.0 = 2.8	E ₂ = 20,000
		16-0 = 16	22.8 - 6.0 = 16.8	E ₃ = 13,000

Note : E₁ = Deformation Modulus
 E₂ = Tangent Elastic Modulus
 E₃ = Secant Elastic Modulus

$$\begin{aligned}
 E_i(\text{kg/cm}^2) &= C \cdot ((1-n^2)/W) \cdot R \cdot (P/A) = (C \cdot (1-n^2) \cdot R/A) \cdot (P/W) \\
 &= 1.76 \cdot ((1-0.25^2) \cdot 30\text{cm} / (60\text{cm} \cdot 60\text{cm})) \cdot (P/A) \\
 &= 0.01375 \cdot P(\text{kg}) / W(\text{cm}) = 13,750 \cdot P(\text{ton}) / W(0.01\text{mm})
 \end{aligned}$$

Table 2.2.4 Relation between seismic velocity and lithology for line SD – 01

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 300 - 400$	Top soil, SILTY CLAY soft, brown.	0.91 – 5.32	0.91 – 5.32
2.	$V_2 = 700 - 1050$	Highly weathered of TUFF CONGLOMERATE; soft to dense, brown to light brown.	7 – 37.5	7.27 – 40.5
3.	$V_3 = 1550$	CONGLOMERATE SANDSTONE, compact, blackish grey	9 – 62.5	16 – 75.21
4.	$V_4 = 2200$	VOLCANIC BRECCIA, compact, light grey	62.5 – infinite	Infinite
5.	$V_5 = 2650$	CONGLOMERATE		

Table 2.2.5 Relation between velocity and lithology for line SD – 02

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 400 - 650$	River Deposit	0.41 – 2.39	0.41 – 2.39
2.	$V_2 = 1500 - 1550$	Toffaceous SANDSTONE, Rather soft dense fine with some gravel	2.5 – 13	3.64 – 14.5
3.	$V_3 = 2200$	Volcanic breccia, Compact, Grey Cemented by tuff, sand	13.5 – 48.5	22.00 – 66.33
4.	$V_4 = 2650$	Toffaceous SANDSTONE	48.5 – infinite	Infinite

Table 2.2.6 ROCK MECHANICAL PROPERTIES DETERMINATION

NO.	SAMPLES	NATURAL DENSITY d gr/cm ³ (3)	NATURAL WATER CONTENT % (4)	SATURATE DENSITY s gr/cm ³ (5)	ABSORPT/ ST. WTR. CONTENT % (6)	DRY DENSITY d gr/cm ³ (7)	DEG. OF SATURATE S % (8)	POROSITY n % (9)	AP. SPEC. GRAVITY (10)	TRUE SPEC GRAVITY (11)	VOID RATIO e (12)
1	B-18 (35.40 - 35.56 m)	1.280	26.88	1.630	61.58	1.009	43.65	62.12	1.0088	2.6634	1.640
2	B-20 (51.26 - 51.46 m)	1.397	29.47	1.679	55.70	1.071	52.91	60.08	1.0787	2.7020	1.505
3	B-20 (48.40 - 48.60 m)	1.338	28.58	1.663	59.80	1.041	47.79	62.24	1.0410	2.7571	1.649
4	B-18 (50.34 - 50.56 m)	1.422	28.07	1.697	52.79	1.111	53.18	58.63	1.1107	2.6848	1.417
5	B-13 (27.15 - 27.40 m)	1.001	16.86	1.513	76.66	0.856	22.00	65.64	0.8562	2.4915	1.910
6	B-18 (37.15 - 37.35 m)	1.617	18.68	1.871	37.36	1.362	50.00	50.89	1.3623	2.7741	1.036
7	B-20 (40.05 - 40.20 m)	0.946	31.65	1.446	101.33	0.718	31.24	72.79	0.7183	2.6401	2.675
8	B-19 (58.50 - 58.67 m)	1.293	34.72	1.589	65.60	0.959	52.92	62.94	0.9595	2.5891	1.698
9	B-18 (34.78 - 35.00 m)	1.221	14.08	1.667	55.75	1.070	25.25	59.67	1.0702	2.6537	1.480
10	B-5 (69.45 - 69.62 m)	0.861	6.27	1.456	79.58	0.811	7.87	64.50	0.8106	2.2836	1.817
11	B-5 (89.69 - 89.88 m)	0.940	21.82	1.475	91.23	0.772	23.92	70.39	0.7715	2.6052	2.377
12	B-5 (84.82 - 85.00 m)	1.276	20.57	1.656	56.48	1.058	36.43	59.76	1.0580	2.6293	1.485
13	B-19 (56.25 - 56.45 m)	1.671	12.62	1.977	33.23	1.484	37.97	49.30	1.4837	2.9267	0.973
14	B-19 (29.20 - 29.40 m)	1.750	13.49	2.006	30.13	1.542	44.77	46.45	1.5419	2.8795	0.868
15	B-18 (40.09 - 40.32 m)	1.919	6.19	2.149	18.96	1.807	32.66	34.26	1.8067	2.7485	0.521
16	B-19 (22.10 - 22.40 m)	2.386	6.72	2.445	9.38	2.236	71.64	20.97	2.2357	2.8288	0.265
17	B-19 (38.70 - 39.00 m)	2.203	11.81	2.238	13.58	1.971	86.93	26.76	1.9705	2.6905	0.365
18	B-20 (43.45 - 43.65 m)	2.061	17.09	2.141	21.60	1.761	79.10	38.03	1.7606	2.8412	0.614
19	B-18 (41.72 - 41.93 m)	1.502	10.77	1.875	38.33	1.355	28.11	51.95	1.3555	2.8212	1.081
20	B-20 (33.30 - 33.45 m)	2.113	12.20	2.186	16.05	1.884	76.00	30.24	1.8836	2.7001	0.433
21	B-20 (45.55 - 45.70 m)	1.452	13.84	1.825	43.11	1.275	32.10	54.98	1.2753	2.8327	1.221
22	B-18 (22.70 - 22.90 m)	2.396	6.87	2.444	8.99	2.242	76.38	20.16	2.2419	2.8081	0.253
23	B-18 (69.10 - 69.32 m)	1.997	19.57	2.062	23.41	1.670	83.59	39.11	1.6704	2.7435	0.642
24	B-20 (75.25 - 75.45 m)	1.716	16.47	1.940	31.70	1.473	51.95	46.70	1.4733	2.7643	0.876
25	B-20 (35.20 - 35.40 m)	1.669	13.88	1.957	33.53	1.466	41.39	49.16	1.4659	2.8832	0.967
26	B-20 (64.80 - 65.00 m)	1.803	14.16	2.005	26.95	1.580	52.53	42.57	1.5795	2.7505	0.741
27	B-19 (23.90 - 24.30 m)	1.314	38.45	1.581	66.51	0.949	57.78	63.13	0.9492	2.5745	1.712

Table 2.2.7 Summary of Unconfined Compression Test

No.	Rock Kind	Rock Classification	Sample No.	Physical Property						Mechanical Property		
				Natural Density gr/cm ³	Saturated Density gr/cm ³	Dry Density gr/cm ³	Natural Water Content %	Absorption %	Degree of Saturation %	Porosity %	Void Ratio	Compression Strength gr/cm ²
1	Tuff	CL - H	B - 13 (27.15 - 27.40 m)	1.001	1.513	0.856	16.860	76.660	22.000	65.640	1.910	13.477
2	Tuff	CL - H	B - 20 (40.05 - 40.20 m)	0.946	1.446	0.718	31.650	101.330	31.240	72.790	2.675	17.450
3	Tuff (Coarse)	CL - H	B - 18 (37.15 - 37.35 m)	1.617	1.871	1.362	18.680	37.360	50.000	50.890	1.036	25.171
4	Tuff (Medium)	CL - H	B - 18 (35.40 - 35.56 m)	1.280	1.630	1.009	26.880	61.580	43.650	62.120	1.640	20.680
5	Tuff (Mudstone)	CL - H	B - 05 (69.45 - 69.62 m)	0.861	1.456	0.811	6.270	79.580	7.870	64.500	1.817	10.284
6	Tuff (Mudstone)	CL - H	B - 05 (84.82 - 85.00 m)	1.276	1.656	1.058	20.570	56.480	36.430	59.760	1.485	5.840
7	Tuff (Sandy)	CL - H	B - 19 (56.25 - 56.45 m)	1.671	1.977	1.484	12.620	33.230	37.970	49.300	0.973	27.457
8	Tuffaceous Sandstone (Fine)	CL - H	B - 20 (51.26 - 51.46 m)	1.397	1.679	1.079	29.470	55.700	52.910	60.080	1.505	13.869
9	Tuffaceous Sandstone (Medium)	CL - H	B - 19 (23.90 - 24.30 m)	1.314	1.581	0.949	38.430	66.510	57.780	63.130	1.712	26.663
10	Tuffaceous Sandstone	CL - H	B - 18 (34.78 - 35.00 m)	1.221	1.667	1.070	14.080	55.750	25.250	59.670	1.480	35.388
11	Sandstone (Medium)	CL - H	B - 20 (48.40 - 48.60 m)	1.338	1.663	1.041	28.580	59.800	47.790	62.240	1.649	9.523
12	Sandstone (Fine)	CL - H	B - 19 (58.50 - 58.67 m)	1.293	1.589	0.939	34.720	65.600	52.920	62.940	1.698	18.506
13	Sandstone (Mudstone)	CL - H	B - 05 (89.69 - 89.88 m)	0.940	1.475	0.772	21.820	91.230	23.920	70.390	2.377	11.394
14	Conglomeratic SS	CM - L	B - 19 (29.20 - 29.40 m)	1.750	2.006	1.542	13.490	30.130	44.770	46.450	0.868	42.907
15	Conglomeratic SS	CL - H	B - 18 (41.72 - 41.93 m)	1.502	1.875	1.355	10.770	38.330	28.110	51.950	1.081	45.444
16	Conglomeratic SS	CM - L	B - 20 (45.55 - 45.70 m)	1.452	1.825	1.275	13.840	43.110	32.100	54.980	1.221	63.798
17	Conglomeratic SS (Upper)	CL - H	B - 18 (40.09 - 40.32 m)	1.919	2.149	1.807	6.190	18.960	32.660	34.260	0.521	64.727
18	Conglomeratic SS (Upper)	CM - L	B - 20 (43.45 - 43.65 m)	2.061	2.141	1.761	17.090	21.600	79.100	38.030	0.614	42.907
19	Conglomeratic SS (Fine)	CL - H	B - 18 (50.34 - 50.56 m)	1.422	1.697	1.111	28.070	52.790	53.130	58.630	1.417	7.508
20	Conglomeratic SS (Coarse)	CL - H	B - 20 (35.20 - 35.40 m)	1.669	1.957	1.466	13.380	33.530	41.390	49.160	0.967	56.094
21	Conglomeratic	CM - L	B - 19 (22.10 - 22.40 m)	2.386	2.445	2.236	6.720	9.380	71.640	20.970	0.265	55.483
22	Volcanic Breccia (Upper Layer)	CM - H	B - 19 (38.70 - 39.00 m)	2.203	2.238	1.971	11.810	13.580	86.950	26.760	0.365	98.482
23	Volcanic Breccia (Upper Layer)	CM - H	B - 20 (33.30 - 33.45 m)	2.113	2.186	1.884	12.200	16.050	76.000	30.240	0.433	66.365
24	Volcanic Breccia (Upper Layer)	CM - L	B - 18 (22.70 - 22.90 m)	2.396	2.444	2.242	6.870	8.990	76.380	20.160	0.253	92.361
25	Volcanic Breccia (Lower Layer)	CM - H	B - 18 (69.10 - 69.32 m)	1.997	2.062	1.670	19.570	23.410	83.590	39.110	0.642	27.704
26	Volcanic Breccia (Lower Layer)	CM - H	B - 19 (75.25 - 75.45 m)	1.716	1.940	1.473	16.470	31.700	51.950	46.700	0.876	21.191
27	Volcanic Breccia (Lower Layer)	CM - H	B - 20 (64.80 - 65.00 m)	1.893	2.005	1.580	14.160	26.950	52.530	42.570	0.741	29.091

Table 2.2.8 Summary of Loading Test in Boreholes

Borehole No.	Test Point		Condition			Result of Test							Note
	Depth (m)	Point No.	Target Layer	Rock Classification	Elastic Module (kgf/cm ²)	Deformation Module (kgf/cm ²)	Critical Point (kgf/cm ²)	Yield Point (kgf/cm ²)	Maximum Stress of the Test (kgf/cm ²)	Radius at the Maximum Stress (mm)	Initial Radius (mm)		
B - 32	9.7	B32 - 1	Tuffaceous Sandstone	CL - L	1,132	453	5.1	9.0	18.0	40.03	37.41		
	13.0	B32 - 2	Sandstone	CL - L	1,546	647	5.1	11.0	25.2	41.68	35.65		
	19.0	B32 - 3	Fine Sandstone	CL - L	1,440	729	5.1	11.0	29.9	41.87	35.88		
	23.8	B32 - 4	Tuffaceous Sandstone	CL - L	599	445	5.1	17.9	32.3	43.36	36.10		
	28.5	B32 - 5	Volcanic Breccia	CL - L	5,828	3,404	14.1	28.0	60.1	40.60	36.70		
	33.0	B32 - 6	Volcanic Breccia	CM - H	7,743	4,187	10.1	30.1	100.0	39.44	36.31		
	37.8	B32 - 7	Volcanic Breccia	CM - H	33,072	14,163	10.2	30.0	100.0	38.63	37.42		
	45.9	B32 - 8	Sandstone	CL - H	7,549	2,811	10.2	29.9	80.2	42.73	36.24		
	53.1	B32 - 9	Sandstone	CL - H	17,246	9,731	10.1	29.9	101.4	42.15	35.95		
	58.0	B32 - 10	Conglomeratic Sandstone	CL - H	4,724	2,665	10.0	30.0	80.5	42.98	39.93		
B - 33	63.5	B32 - 11	Conglomeratic Sandstone	CL - H	7,965	4,260	10.0	30.1	100.0	40.77	38.07		
	68.6	B32 - 12	Fine Sandstone	CL - H	50,076	15,017	10.0	30.0	100.2	38.61	35.75		
	73.5	B32 - 13	Tuff	CL - H	4,262	2,655	10.1	30.0	59.5	44.57	38.54		
	77.0	B32 - 14	Fine Sandstone	CL - H	11,154	7,566	10.1	30.0	70.0	39.83	35.23		
	84.0	B32 - 15	Volcanic Breccia	CM - H	11,042	6,238	10.1	30.0	99.8	39.37	35.95		
	16.5	B33 - 1	Volcanic Breccia	CM - H	11,052	4,308	10.2	30.0	100.0	38.92	35.12		
	21.8	B33 - 2	Volcanic Breccia	CM - H	7,209	4,730	10.0	20.0	30.0	38.89	35.80		
	25.8	B33 - 3	Volcanic Breccia	CM - H	6,399	3,843	10.1	30.2	100.2	39.96	35.60		
	29.5	B33 - 4	Volcanic Breccia	CM - H	2,182	1,537	10.0	20.0	100.1	40.57	34.98		
	34.5	B33 - 5	Volcanic Breccia	CM - H	9,212	7,601	10.0	30.0	100.1	39.27	34.99		

Table 2.2.9 Summary of Plate Loading Test in Adits

Test Point			Condition			Result of Test						
Adit No.	Depth (m)	Point No.	Target Layer	Rock Classification	Elastic Module (kgf/cm ²)	Deformation Module (kgf/cm ²)	Critical Point (kgf/cm ²)	Strain at the Critical Point (mm)	Maximum Stress of the Test (kgf/cm ²)	Strain at the Maximum Stress (mm)	Final Displacement of Loading Plate (mm)	Note
T 1	13.5	T1 - 1	Fine grained Sandstone	CM - L	9,323	5,628	---	---	35.1	1.39	0.64	
	7.5	T1 - 2	Coarse grained Sandstone	CL - H	15,177	6,092	---	---	35.4	1.41	0.94	
T 3	19.0	T3 - 1	Tuffaceous Sandstone	CL - L	8,635	6,326	---	---	35.3	1.20	0.56	
	11.0	T3 - 2	Tuffaceous Sandstone	CL - L	2,872	2,110	29.5	3.89	35.5	11.87	9.68	
T 4	27.0	T4 - 1	Fine Sandstone with Gravel	CL - L	7,483	1,798	---	---	37.5	4.00	3.83	
	21.5	T4 - 2	Fine grained Sandstone	CL - L	4,161	1,973	29.9	3.47	35.6	4.94	7.63	

* Strain and Displacement are shown by your strain sensor average

Table 2.3.1 Summary of Lugeon Test (Reservoir Area)

Hole No.	Stage Number	Section of Test	Rock Unit Name	Rock Classification	Lugeon Value	Critical Point		Maximum Point	
						Pc	Qu c	Pm	Qm
RA - 1	1	5.00 - 10.00	Mudstone	CL - L	32.21	1.23	3.96	1.23	3.96
	2	10.00 - 15.00	Mudstone	CL - L	4.50	3.48	1.06	4.44	4.10
	3	15.00 - 20.00	Mudstone	CL - L	4.28	2.51	0.50	4.05	12.28
	4	20.00 - 25.00	Mudstone	CL - L	0.23	2.51	0.03	3.79	11.43
	5	25.00 - 30.00	Mudstone	CL - L	0.95	3.58	0.16	4.15	11.70
RA - 2	1	5.15 - 10.00	Mudstone	CL - L	42.60	0.98	4.16	2.54	18.80
	2	10.00 - 15.00	Mudstone	CL - L	5.10	1.54	0.78	2.58	14.48
	3	15.00 - 20.00	Mudstone	CL - L	4.34	2.54	0.51	4.08	12.28
	4	20.00 - 25.00	Mudstone	CL - L	3.29	1.58	0.52	3.25	14.52
	5	25.00 - 30.00	Mudstone	CL - L	0.27	1.58	0.04	3.34	7.10
	6	30.00 - 35.00	Mudstone	CL - L	0.40	2.61	0.05	4.30	7.40
RA - 3	1	5.00 - 10.00	Mudstone	CL - L	80.10	1.85		1.15	9.25
	2	10.00 - 15.00	Mudstone	CL - L	28.52	2.94	12.16	3.54	18.12
	3	15.00 - 20.00	Mudstone	CL - L	>100			1.44	16.40
	4	20.00 - 25.00	Mudstone	CL - L	0.06	3.27	0.02	4.26	1.26
	5	25.00 - 30.00	Mudstone	CL - L	3.58	4.31	1.29	5.88	9.56
RA - 4	1	5.00 - 10.00	Tuffaceous Sandstone	CL - L	4.10	1.84	0.76	2.66	11.20
	2	10.00 - 15.00	Tuffaceous Sandstone	CL - L	93.54	1.73	16.16	1.97	19.28
	3	15.00 - 20.00	Tuffaceous Sandstone	CL - L	1.71	4.04	0.52	5.00	3.58
	4	20.00 - 25.00	Cong'ic S'Stone	D	5.74	3.00	1.10	3.56	18.80
	5	25.00 - 30.00	Cong'ic S'Stone	CL - L	3.57	2.88	0.32	4.17	12.00
	6	30.00 - 35.00	Siltstone	CL - L					
	7	37.00 - 40.00	Volc. Conglomerate	CL - H	1.50	11.00	1.60	11.00	1.60
RA - 5	1	8.40 - 10.00	Siltstone	CL - L	26.24	5.88	15.21	5.88	15.21
	2	10.00 - 15.00	Siltstone	CL - L	23.19	2.33	5.40	2.33	5.40
	3	15.00 - 20.00	Volc. Conglomerate	CL - L	0.85	4.75	0.44	5.60	7.00
	4	20.00 - 25.00	Tuffaceous Sandstone	CL - L	0.60	6.25	0.34	8.12	5.68
	5	25.00 - 30.00	Tuffaceous Sandstone	CL - L	1.38	4.15	0.55	6.04	4.86

Table 2.4.1 Relation between seismic velocity and lithology on Lines S – 01

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 350 - 600$	Top Soil, silty CLAY to sandy SILT, soft, firm moist, high plastic	0.73 – 5.24	0.73 – 5.24
2.	$V_2 = 750 - 1500$	Andesite with extremely weak to weak	5.5 – 27.9	6.5 – 29.9
3.	$V_3 = 2500 - 3330$	Andesite, medium strong to strong	27.9 – infinite	Infinite

Table 2.4.2 Classified seismic velocity and kind of rock for Line S – 02

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 500 - 600$	Top Soil, silty CLAY to sandy SILT, soft, firm moist, high plastic	0.86 – 4.31	0.86 – 4.31
2.	$V_2 = 1000 - 1400$	Andesite with extremely weak to weak	14.5 – 29.5	17.5 – 33.5
3.	$V_3 = 2500$	Andesite, medium strong to strong	29.5 – infinite	Infinite

Table 2.4.3 Classified seismic velocity and kind of rock for Line S – 03

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 450 - 600$	Top Soil, silty CLAY to sandy SILT, soft, firm moist, high plastic	0.12 – 5.67	0.12 – 5.67
2.	$V_2 = 900 - 1100$	Andesite with extremely weak to weak	5.30 – 13.22	8.91 – 16.62
3.	$V_3 = 2400 - 2500$	Andesite, medium strong to strong	13.22 – infinite	Infinite

Table 2.4.4 Classified seismic velocity and kind of rock for Line S – 04

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 350 - 600$	Top Soil, silty CLAY to sandy SILT, soft, firm moist, high plastic	1.31 – 4.52	1.31 – 4.52
2.	$V_2 = 870 - 1500$	Andesite with extremely weak to weak	5.5 – 12.5	8.57 – 14.37
3.	$V_3 = 2400$	Andesite, medium strong to strong	12.5 – infinite	Infinite

Table 2.4.5 Classified seismic velocity and kind of rock for Line S – 05

No.	Seismic Velocity (m/s)	Lithology unit	Thickness (m)	Depth (m)
1.	$V_1 = 450 - 600$	Top Soil, silty CLAY to sandy SILT, soft, firm moist, high plastic	1.5 – 5.12	1.5 – 5.12
2.	$V_2 = 850 - 1150$	Andesite with extremely weak to weak	5.5 – 23.20	8.5 – 28.20
3.	$V_3 = 2200 - 2400$	Andesite, medium strong to strong	23.20 – infinite	Infinite

Table 2.4.6 Laboratory Test Result of Core Sample

No.	Sample	Depth (M)	Rock Classification	Physical Properties				Mechanical Test
				Natural Density (gr/cm ³)	Saturated Density (gr/cm ³)	Dry Density (gr/cm ³)	Absorpt. Sat. Water Content (%)	
1	A-1	11.80 - 12.00	CL	2.04	2.18	1.95	11.87	46.151
2	A-1	26.00 - 26.30	CM	2.32	2.42	2.25	7.52	303.953
3	A-2	8.10 - 8.35	CH	2.39	2.50	2.38	4.95	408.027
4	A-2	36.00 - 26.30	CM	2.67	2.70	2.64	2.21	1,068.561
5	A-3	37.00 - 37.20	CM	2.63	2.67	2.62	1.87	863.916
6	A-3	61.60 - 61.80	CML	2.55	2.60	2.53	2.70	391.348
7	A-4	12.50 - 12.65	CL	1.59	1.76	1.53	15.11	28.297
8	A-4	15.50 - 15.70	CML	2.23	2.35	2.17	8.24	102.830
9	A-6	12.30 - 12.60	CLH	2.33	2.45	2.30	6.50	171.484
10	A-6	35.00 - 35.35	CLH	2.35	2.47	2.33	6.06	463.825
11	A-6	58.00 - 58.25	CLH	2.39	2.49	2.38	4.73	484.078
12	A-7	39.80 - 40.00	CM	2.74	2.75	2.73	0.62	432.993
13	A-7	67.20 - 67.45	CLH	2.22	2.40	2.20	8.78	164.904
14	A-8	7.45 - 7.60	CM	1.79	2.00	1.72	16.58	30.721
15	A-8	21.00 - 21.25	CL	2.57	2.60	2.55	2.03	770.463
16	A-9	25.75 - 26.00	CH	2.70	2.73	2.69	1.67	580.865
17	A-10	24.00 - 24.20	CLH	2.21	2.34	2.19	6.78	231.567
18	A-10	32.35 - 32.50	CM	2.37	2.45	2.35	4.27	451.607
19	A-11	21.00 - 21.20	CM	2.68	2.74	2.65	3.64	649.962
20	A-12	17.00 - 17.20	CH	2.65	2.66	2.62	1.52	580.218

Table 2.4.7 Laboratory Test Result of Aggregate Sample

No.	Sample	Rock Classification	Physical Properties				Mechanical Test	
			Natural Density	Saturated Density	Dry Density	Absorpt. Sat. Water Content	Sc	Re
			(gr/cm ³)	(gr/cm ³)	(gr/cm ³)	(%)	(mmol/l)	(mmol/l)
1	A - 1/1	CM	2.55	2.59	2.54	2.22	36.30	221.12
2	A - 1/2	CM	2.48	2.55	2.47	3.04	36.30	221.12
3	A - 1/3	CM	2.58	2.60	2.57	1.34	36.30	221.12
4	A - 2/1	CM	2.54	2.59	2.53	2.46	29.64	215.30
5	A - 2/2	CM	2.54	2.59	2.52	2.40	29.64	215.30
6	A - 2/3	CM	2.54	2.57	2.52	1.92	29.64	215.30
7	B - 1/1	CL	2.24	2.27	2.22	2.09	10.65	288.30
8	B - 1/1	CL	2.29	2.34	2.27	2.99	10.65	288.30
9	B - 1/1	CL	2.32	2.37	2.30	3.39	10.65	288.30
10	B - 1/2	CM	2.50	2.53	2.49	1.84	10.65	288.30
11	B - 1/2	CM	2.51	2.53	2.48	1.87	10.65	288.30
12	B - 1/2	CM	2.52	2.54	2.48	2.54	10.65	288.30
13	B - 1/3	CL	2.09	2.22	2.01	10.35	10.65	288.30
14	B - 1/3	CL	2.13	2.27	2.08	8.87	10.65	288.30
15	B - 1/3	CL	2.17	2.28	2.10	8.54	10.65	288.30

Table 2.4.8 Chemical Analysis Result of The Dried Samples (105 °C, % mmol/l)

Project : UDWRD Semarang

Material : Aggregate

Item	Sample No.		
	A1	A2	B
Dissolved Silica (SC)	36.30	29.64	10.65
Reduction in Alkalinity (RC)	221.12	215.30	288.30

Table 2.4.9 Summary of Laboratory Test (Fine Material of Borrow Area)

THE DETAILED DESIGN OF
FLOOD CONTROL, URBAN DRAINAGE, AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

LOCATION	SAMPLE NUMBER	PHYSICAL PROPERTIES										MECHANICAL PROPERTIES																					
		Basic Condition					Grain Size					Consistency			USCS				Proctor Compaction				Shearing Strength					Permeability					
		Gs	Wa (%)	Proportion					Index					Cohesion			y _{dmax} (mm)	y _d (mm)	w _p (%)	y _d (mm)	CU				D ₉₅ Wet Side (%)	Falling Head Method							
				5% S	10% S	20% S	40% S	60% S	100% S	D ₄₀ (mm)	D ₆₀ (mm)	D ₁₀₀ (mm)	D _{max} (mm)	C _u	C _c	LL (%)					PL (%)	PI (%)	γ _d (mm)	w (%)			C (%)	φ (degrees)	c' (kPa)	φ' (degrees)	D ₉₅ (mm)	w (%)	k (cm/min)
(%)	(%)	(%)	(%)	(%)	(%)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)						
AREA A	TPA-1U	2.732	41.11	-	4.08	31.32	64.40	0.850	-	-	-	77.00	45.75	31.25	MH	1.250	39.60	44.00	1.190	44.00	-	-	-	-	-	-	-	-	-	-	-		
	TPA-1L	2.695	43.96	-	6.53	53.47	40.00	0.850	-	0.092	81.40	45.53	35.87	MH	1.195	43.65	48.60	1.135	48.60	-	-	-	-	-	-	-	-	-	-	-	-		
	TPA-2U	2.708	36.19	-	4.16	40.34	55.50	0.850	-	0.004	79.23	36.07	43.16	CH	1.307	35.80	39.60	1.241	39.60	-	-	-	-	-	-	-	-	-	-	-	-		
AREA B	TPA-2L	2.654	36.68	-	4.54	45.96	49.50	0.850	-	0.041	81.89	36.72	45.17	CH	1.292	35.90	40.20	1.228	40.20	-	-	-	-	-	-	-	-	-	-	-	-	-	
	TPA-3U	2.608	40.50	-	4.88	31.12	64.00	0.850	-	-	88.10	37.31	50.79	CH	1.237	39.80	42.60	1.176	42.60	-	-	-	-	-	-	-	-	-	-	-	-	-	
	TPA-3L	2.818	29.29	44.06	24.37	15.37	16.00	9.500	-	1.800	83.60	30.77	52.83	CH	1.575	26.80	30.90	1.497	30.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPA-4U	2.625	42.38	-	2.67	42.33	55.10	0.850	-	0.070	84.60	38.07	46.43	CH	1.257	39.00	43.00	1.191	43.00	41.64	8.26	37.07	20.89	1.191	43.00	41.64	8.26	37.07	20.89	1.191	43.00	1.92E-07	
	TPA-4L	2.668	40.59	-	10.85	42.65	46.50	0.850	-	0.012	79.30	35.44	43.86	CH	1.306	37.90	41.50	1.244	41.50	34.08	10.24	24.29	19.36	1.244	41.50	34.08	10.24	24.29	19.36	1.244	41.50	3.67E-06	
AREA C	TPB-1U	2.612	41.96	-	1.28	30.52	68.20	0.850	-	-	95.46	37.51	57.95	CH	1.256	38.90	43.80	1.195	43.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-1L	2.578	45.59	-	4.37	28.13	67.50	0.850	-	-	95.29	40.40	54.89	CH	1.210	42.20	46.50	1.151	46.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-2U	2.611	40.73	-	2.17	35.83	62.00	0.850	-	0.002	102.87	35.49	67.38	CH	1.250	38.80	43.40	1.189	43.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-2L	2.722	45.91	-	3.75	38.25	58.00	0.850	-	0.003	92.75	39.80	52.95	CH	1.197	44.10	48.40	1.138	48.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-3U	2.681	34.71	-	3.91	46.09	50.00	0.850	-	0.008	94.04	34.30	59.74	CH	1.263	37.70	42.50	1.201	42.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AREA D	TPB-3L	2.679	34.47	-	10.48	51.32	38.20	0.850	-	0.012	89.39	37.50	52.43	CH	1.232	40.30	44.40	1.174	44.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-4U	2.690	37.59	-	5.81	56.19	38.00	0.850	-	0.016	89.57	34.70	54.87	CH	1.279	37.61	41.00	1.222	41.00	20.79	11.61	11.35	24.68	1.222	41.00	20.79	11.61	11.35	24.68	1.222	41.00	3.58E-06	
	TPB-4L	2.750	43.16	-	4.69	41.11	54.20	0.850	-	0.005	99.51	34.70	64.81	CH	1.185	43.85	48.00	1.131	48.00	44.74	9.69	27.72	18.64	1.131	48.00	44.74	9.69	27.72	18.64	1.131	48.00	1.32E-07	
	TPB-5U	2.680	39.64	-	2.67	48.33	49.00	0.850	-	0.007	95.29	36.08	59.12	CH	1.227	40.10	44.70	1.169	44.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-5L	2.630	51.12	-	14.00	69.80	16.20	0.850	-	0.010	83.44	37.15	46.29	CH	1.094	49.40	54.50	1.040	54.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AREA D	TPB-6U	2.760	42.45	-	3.25	42.75	54.00	0.850	-	0.005	102.92	48.01	54.91	MH	1.194	42.90	48.20	1.155	48.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPB-6L	2.758	43.50	-	6.60	54.40	48.00	0.850	-	0.006	96.01	45.58	50.43	MH	1.183	44.80	49.60	1.125	49.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPD-1U	2.719	37.93	-	6.23	60.77	33.00	0.850	-	0.001	83.11	33.71	49.40	CH	1.283	38.90	43.00	1.220	43.00	24.46	10.70	16.92	25.52	1.220	43.00	24.46	10.70	16.92	25.52	1.220	43.00	1.19E-07	
	TPD-1L	2.696	43.67	-	9.49	69.51	21.00	0.850	-	0.060	77.84	37.06	40.78	MH	1.193	43.00	47.60	1.132	47.60	42.22	9.40	41.35	17.44	1.132	47.60	42.22	9.40	41.35	17.44	1.132	47.60	2.00E-07	
	TPD-2U	2.689	41.12	-	10.79	66.21	23.00	0.850	-	0.044	92.19	38.04	54.15	CH	1.225	41.60	45.80	1.165	45.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPD-2L	2.676	36.94	-	8.47	61.76	29.50	0.850	-	0.003	65.39	31.11	34.28	CH	1.265	39.20	43.70	1.203	43.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 2.4.10 Summary of Laboratory Test (Mixed Material : Crushed Rock and Fine Material)

THE DETAILED DESIGN OF
FLOOD CONTROL, URBAN DRAINAGE, AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

MATERIAL KIND	CASE NUMBER	PHYSICAL PROPERTIES										MECHANICAL PROPERTIES																								
		Basic Condition		Grain Size				Proportion				Consistency		Proctor Compaction		Shearing Strength					Permeability															
		Gs	Wn (%)	GRAVEL > 4.75mm (%)	SAND 0.075mm - 4.75 (%)	SILT 0.075mm - 0.0075mm (%)	CLAY < 0.0075mm (%)	Dmax (mm)	D10 (mm)	D30 (mm)	D60 (mm)	Cu	Cc	LL (%)	PL (%)	PI (%)	Wpopt (%)	γdmax (g/cm ³)	γdmax (g/cm ³)	D95:Wet Side γd (%)	D95:Wet Side w (%)	φ (degree)	C (kPa)	φ' (degree)	C' (kPa)	φ' (degree)	γd (g/cm ³)	w (%)	k (cm/sec)	k (cm/sec)	k (cm/sec)					
CRUSHED MATERIAL AND FINE MATERIAL	CASE 1	2.733	17.47	23.30	32.90	23.80	22.00	19	0.0350	0.2750	-	45.00	15.73	29.27	1.674	20.5	1.59	24.30	33.64	15.89	26.96	25.63	1.590	20.50	2.290E-07	1.00E-05										
	CASE 2	2.737	13.95	21.20	50.10	18.10	10.60	19	0.0044	0.1000	0.8500	193.18	2.67	35.89	12.93	20.96	1.798	16.5	20.00	18.90	11.86	31.32	1.708	16.50	6.399E-06	1.92E-05										
	CASE 3	2.739	8.11	20.05	50.05	18.90	11.00	19	0.0043	0.1200	0.8500	197.67	3.94	28.44	13.21	15.23	1.934	13.8	17.00	17.43	11.35	29.30	1.837	13.80	1.04E-05	3.01E-05										
	CASE 4	2.752	11.65	29.00	41.50	18.45	11.05	19	0.0040	0.1300	1.5000	375.00	2.82	28.20	12.00	16.20	1.865	14.8	17.00	45.97	12.21	37.87	20.39	1.772	14.80	9.62E-06	2.74E-05									
	CASE 5	2.716	12.58	20.00	50.00	20.00	10.00	19	0.0045	0.0900	0.9500	211.11	1.89	35.14	13.10	22.04	1.83	15.5	18.90	12.97	16.60	5.52	36.00	1.738	15.50	3.56E-06	1.15E-05									

Table 2.4.11 Summary of Laboratory Test (Coarse Material : Borrow Area, Crushed Rock and Natural Sand)

THE DETAILED DESIGN OF
FLOOD CONTROL, URBAN DRAINAGE, AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

LOCATION AND MATERIAL KIND	SAMPLE AND CASE NUMBER	PHYSICAL PROPERTIES										MECHANICAL PROPERTIES														
		Basic Condition		Grain Size							Consistency		Relative Density			Shearing Strength			Permeability							
		Gs	Wn (%)	Proportion			Index				LL (%)	PL (%)	PI (%)	w (%)	γ_{dmax} (g/cm ³)	γ_{dmin} (g/cm ³)	C (kPa)	ϕ (degree)	γ_d (g/cm ³)	w	k (cm/sec)					
				GRAVEL > 4.75 mm	SANDS 0.075 - 4.75 mm	SILT 0.075 - 0.005 mm	Dmax (mm)	D ₁₀ (mm)	D ₃₀ (mm)	D ₆₀ (mm)												Cu	Cc			
AREA C	TPC-1	2.603	10.150	68.00	26.00	6.00	77.00	0.42	2.50	23.00	54.76	0.65	-	-	-	-	-	-	-	-	-					
	TPC-2	2.582	20.230	32.00	48.00	20.00	75.00	-	0.25	15.00	-	-	-	-	-	-	-	-	-	-	-					
	TPC-4	2.554	20.230	17.00	14.00	15.00	145.00	-	7.00	50.00	-	-	-	-	-	-	-	-	-	-	-					
	TPC-6	2.603	26.380	50.00	32.00	18.00	96.00	-	5.00	15.00	-	-	-	-	-	-	-	-	-	-	-					
UNGARAN CRUSHED MATERIAL	4.75 under	2.631	0.740	-	99.00	1.00	4.75	3.40	0.80	20.00	5.88	0.01	-	-	-	-	-	-	-	-	-					
	19.1 under (A)	2.650	0.770	95.00	5.00	-	19.00	6.00	9.00	14.00	2.33	0.96	-	-	-	-	-	-	-	-	-					
	19.1 under (B)	2.650	0.770	96.00	4.00	-	19.00	6.00	9.00	14.00	2.33	0.96	-	-	-	-	-	-	-	-	-					
	CASE 1	2.637	2.920	35.00	65.00	-	19.00	6.00	18.00	41.00	6.83	1.32	-	-	-	-	-	-	2.92	1.979	1.412	1.64	35.68	1.854	2.93	4.09E-03
MUNTILAN SAND AND CRUSHED MATERIAL	CASE 2	2.642	2.260	64.00	36.00	-	19.00	1.30	3.80	10.00	7.69	1.11	-	-	-	-	-	-	2.26	1.968	1.450	3.19	35.46	1.831	2.27	1.14E-02
	SAND	2.645	0.630	10.00	83.00	7.00	9.50	0.11	0.31	0.90	8.18	0.97	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CASE 1	2.600	0.658	36.00	60.40	3.60	19.00	0.18	0.65	35.00	194.44	0.07	-	-	-	-	-	-	0.66	2.164	1.653	1.90	24.00	1.854	2.93	1.36E-04
	CASE 2	2.598	0.765	58.90	38.80	2.30	19.00	0.32	2.00	11.00	34.38	1.14	-	-	-	-	-	-	0.77	2.141	1.563	7.28	36.60	2.023	0.77	2.72E-03

Table 2.4.12 Summary of Soil Test Result (1)

THE DETAILED DESIGN OF
FLOOD CONTROL, URBAN DRAINAGE, AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

Properties	Sample No.	Original Sample		Test Sample	
		eb=0.257	eb=0.221		eb=0.283
Specific Gravity of Soil	Real	2.780		2.780	
	Over-Dry	2.544		2.544	
Water Content (%)	Surface-Dry	2.629		2.629	
	w	0.80		0.80	
Proportion	Gravel Part (%)	80		90	
	Sand Part (%)	20		10	
	Silt Part (%)	-		-	
	Clay Part (%)	-		-	
Grain Size	Max Diameter	63.0		63.0	
	60% Diameter	15.0		15.0	
	30% Diameter	4.26		4.42	
	10% Diameter	1.28		2.00	
	Uniformity Coefficient	11.72		7.50	
Compaction	Curvature Coefficient	0.945		0.651	
	Method: The Duration of the Shock	60	300	0	300
Permeability	Wet Density	2.040	2.100	1.572	1.936
	Dry Density	2.240	2.083	1.560	1.946
	Void Ratio	0.257	0.221	0.631	0.307
Shearing Strength	Coefficient of Permeability	5.41E-02	8.00E-03		7.13E-02
	Unconfined Compression				
	Direct Compression				
	Triaxial Compression				
	Internal Friction Angle				
Grain Size (Tested)	Condition				
	Gravel Part (%)			91	90
Grain Size (Tested)	Sand Part (%)			9	10
	Silt Part (%)			-	-
	Clay Part (%)			-	-
	Max Diameter			63.0	63.0
	60% Diameter			15.0	13.8
	30% Diameter			4.49	4.41
	10% Diameter			2.11	2.07
	Uniformity Coefficient			7.11	6.67
	Curvature Coefficient			0.637	0.681
	Percent of Particle Breakage			±4.6	±3.3

Table 2.4.13 Summary of Soil Test Result (2)

THE DETAILED DESIGN OF
FLOOD CONTROL, URBAN DRAINAGE, AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

Properties	Sample No.	eb=0.325 60sec				eb=0.283 300sec				eb=0.257 60sec				eb=0.221 300sec			
		Specific Gravity of Soil	Real G_g (g/cm ³)	Oven-Dry G_b (g/cm ³)	Surface-Dry G_a (g/cm ³)	Water Content w (%)	Gravel Part (%)	Sand Part (%)	Silt Part (%)	Clay Part (%)	Max Diameter (mm)	60% Diameter D60 (mm)	30% Diameter D30 (mm)	10% Diameter D10 (mm)	Uniformity Coefficient U_c	Curvature Coefficient U_c'	
Grain Size	Method: The Duration of the Shock																
	Wet Density ρ_t (g/cm ³)																
Compaction	Dry Density ρ_d (g/cm ³)																
	Void Ratio e_b																
Permeability	Coefficient of Permeability k_{15} (cm/sec)																
	Unconfined Compression Strength																
Shoring Strength	Compression Sensitivity																
	Direct Compression Cohesion C (kg/cm ²)																
Shoring Strength	Internal Friction Angle ϕ																
	Triaxial Compression Cohesion C (kg/cm ²)																
Shoring Strength	Internal Friction Angle ϕ																
	Condition																
Grain Size (Tested)	Gravel Part (%)	81	79	75	73												
	Sand Part (%)	19	21	25	27												
Grain Size (Tested)	Silt Part (%)	-	-	-	-												
	Clay Part (%)	-	-	-	-												
Grain Size (Tested)	Max Diameter (mm)	63.0	63.0	63.0	63.0												
	60% Diameter D60 (mm)	12.6	12.1	13.0	11.9												
Grain Size (Tested)	30% Diameter D30 (mm)	3.25	2.98	2.82	2.48												
	10% Diameter D10 (mm)	1.14	0.990	1.01	0.910												
Grain Size (Tested)	Uniformity Coefficient U_c	11.1	12.2	12.9	13.1												
	Curvature Coefficient U_c'	0.735	0.741	0.606	0.568												
Grain Size (Tested)	Percent of Partic Breakage E (%)	±8.8	±11.4	±7	±8.2												

Table 2.4.14 Summary of Soil Test Result (3)
(Triaxial Compression Test)

THE DETAILED DESIGN OF
FLOOD CONTROL, URBAN DRAINAGE, AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

Sample No.	eb=0.325 60sec (Partially Saturated)				eb=0.283 300sec (Partially Saturated)				eb=0.257 60sec (Partially Saturated)				eb=0.221 300sec (Partially Saturated)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Specimen Size (cm)	87.9															
Establish Grain Size Analysis	100.0															
Relative Density D_r (%)	107.5															
Specimen No.	117.8															
Consolidation Pressure σ_v (kgf/cm ²)	0.50				1.00				3.00				6.00			
Specific Gravity G_s (g/cm ³)	2.544															
Water Content w (%)	0.80															
Coefficient of Uniformity U_c	3.34															
Percent of Suck up Moisture Q (%)	3.34															
Dry Density ρ_d (g/cm ³)	1.921															
Void Ratio	Before Consolidation e_{b0}	0.325	0.325	0.325	0.325	0.283	0.283	0.283	0.283	0.257	0.257	0.257	0.257	0.221	0.221	0.221
	After Consolidation e_{bc}	0.315	0.315	0.315	0.315	0.257	0.257	0.257	0.257	0.252	0.252	0.252	0.252	0.216	0.216	0.216
	Breakage e_f	0.329	0.332	0.32	0.29	0.312	0.288	0.276	0.264	0.271	0.263	0.241	0.216	0.236	0.23	0.216
Principal Stress Difference $\sigma_1 - \sigma_3$ (kgf/cm ²)	9.638	12.500	21.112	30.635	10.675	12.625	20.447	32.129	8.365	10.598	19.615	33.142	9.225	11.546	20.858	34.787
Volume Strain v_r (%)	-1.07	-1.38	-0.62	1.19	-2.85	-1.15	-0.34	0.53	-1.58	-1.26	-0.23	1.23	-1.72	-1.38	-0.84	0.06
Modulus of Deformation E_s (kgf/cm ²)	983	1157	1508	1647	905	986	1526	2171	804	1152	1486	1493	114	1480	2006	2202
Poisson's Ratio ν	0.713	0.672	0.556	0.421	0.973	0.664	0.531	0.455	0.816	0.657	0.523	0.419	0.930	0.845	0.667	0.495
Percent of Partical Breakage B (%)	±8.8															
$\phi_d = C_o$ Material Internal Friction Angle	64.99															
	59.55															
$\tau_{1/2} = C_d + \sigma_{1/2} \tan \phi_d$	40.92															
	1.94															
$\sigma_{n=15}$	15.2															
	14.9															
ϕ_d	41.38															
	43.87															
C_d	1.97															
	1.29															
$\sigma_{n=15}$	15.7															
	16.1															