3-20 Myeongcheon

(1) Outline of Project

Dam type : Rockfill
Dam height : 61 m
H.W.L : EL. 150 m
Power station : Attached to the dam

(2) Topography and Geology of Reservoir Area

The river in the reservoir area is of gentle gradient, with much meandering, borad width, and moreover, large-scale river terraces at meanders and in the vicinities of junctions with major tributaries, to indicate a so-called old-age topography.

The geology consists of granite and quartz porphyry with large quantities of sand-gravel deposits seen at the riverbed, while distributions of talus deposit at parts above the beforementioned river terrace are prominent.

There is little devastation of the mountain area such as landslides and collapses in this reservoir area which possesses the topography and geology as described above, while moreover, the river banks of large tributaries are developed as rice paddies so that there is stability as a whole. According to the survey reports on the two project sites of Sutong and Yongdam planned upstream of this reservoir, a planned sedimentation of 90-100 $m^3/km^2/year$ is used.

(3) Topography and Geology of Damsite

Topography

The damsite is located at a point approximately 6 km upstream from Yangan Bridge where National Route No.4 crosses the Geum River at Sanggotan. The river flows roughly in a straight line from southwest to northeast in the vicinity of the damsite. The width of the river at the dam axis is approximately 140 m, with both left and right banks slopes of about 30° to 45°, while bedrocks are seen near the roadsides at both banks. A river deposit of the present stream and a largescale river terrace are formed at the meander of the river at the right bank

upstream the damsite. Further, at the left bank of the damsite, there is formed a small-scale saddle in a continuation from the abutment.

Geology

Left Abutment: The basement rock is a coarse-grained phanero-crystalline granite but the abutment from about 3 m above the road consists of (a dyke of) quartz-porphyry. Both rocks are extremely hard and dense, and there is no problem with regard to the foundation for the proposed dam. Granite of good quality similarly to that at the dam axis is distributed at the small-scale saddle continuing from the abutment up to a height of 15 to 20 m from the road, but higher above is quartz-porphyry extending from the dam abutment. The top of the saddle is covered by slope wash and the condition of the basement rock is unknown.

Riverbed: The entire riverbed is covered by sand-gravel and there are no outcrops of basement rock. However, seen from the outcrops on the both banks, it is considered the basement rock is probably granite in the main. Although the thickness of the river deposit has not yet been investigated, considering the cases of the upstream Sutong and Yongdam sites, it is estimated to be 5 to 10 m.

Right Abutment: The basement rock is a phanerocrystalline granite. On the dam axis, outcropping of the basement rock can be seen more or less over the entire surface. The granite from the river bank to a height approximately 10 m above the road has few cracks and is a good foundation rock, but above this and the upstream and downstream sides of the axis are covered by thin slope wash and weathering and irregular open cracks are conspicuous in the basement rock.

(4) Geology of Appurtenant Structure Site

A powerstation is planned to be built joining the dam, but its location is still undecided. Geologically, it will be quite acceptable for either the left or right bank to be selected. Based on a topographical judgment, it is thought a location taking advantage of the left-bank saddle will be suitable.

(5) Material

The proposed dam is a rockfill dam. Although particulars such as the volume of the dam have not yet been determined, judging by the planned height of the dam, it will be possible to readily obtain the necessary amount of rock fill materials from the upstream and downstream river deposits and the granite mass vicinity of the damsite. Impervious core material is not investigated yet on this time.

(6) Comments

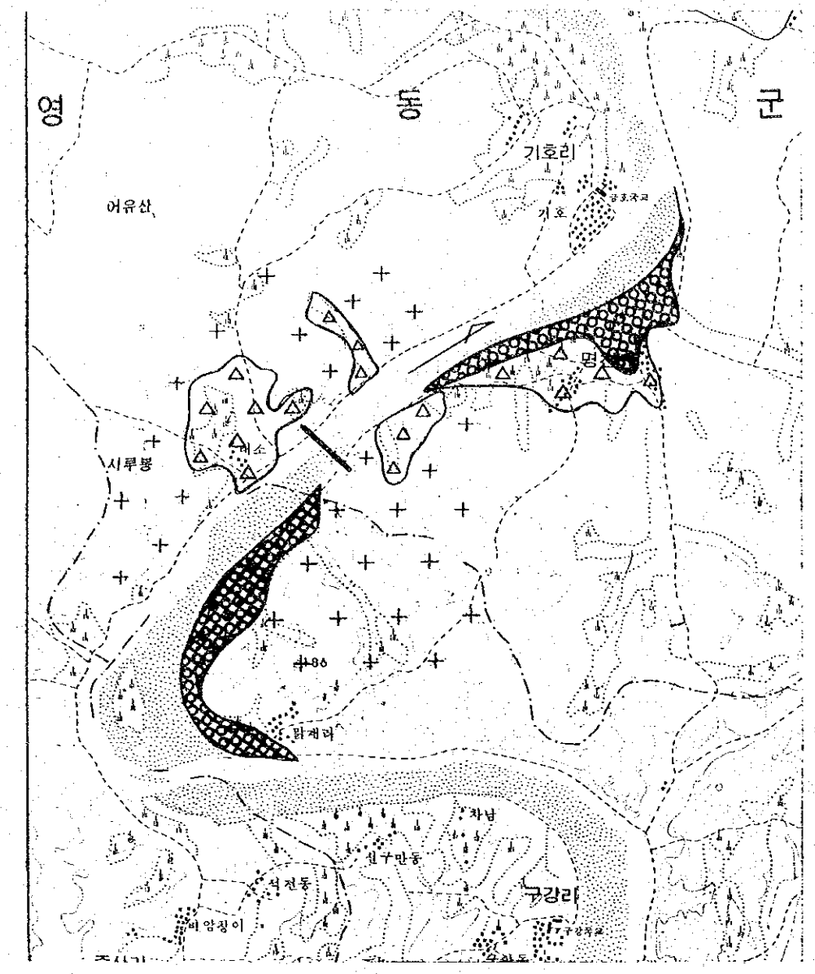
A) The basement rock of this site is of adequately good quality as the foundation for the proposed dam. However, the top of the saddle extending from the left bank is covered by slope wash, and since the thickness of the slope wash and the condition of weathering of the basement-rock (quartz-porphyry) are unknown, investigation should be made by drill holes combining permeability tests.

B) The thicknees of the river deposit and the weathered and cracky granite upstream and downstream of the right abutment should be investigated by drill holes.

C) Although the natural river deposits distributed upstream and downstream the dam axis are estimated to be adequate both in quality and quantity, the outward appearance is that the sand content is high and coarse aggregate is small in quantity. It will be necessary to carry out gradation tests of the natural river deposit.

D) The mountains of the reservoir area are stable. However, since the greater part of this reservoir is comprised of granite, the condition of weathering should be investigated and the sandy material carried into the reservoir in the future estimated, which will provide useful information for studying the necessity of sand discharge facilities and their sizes in designing of the dam.

E) It is estimated that excavation for the dam foundation will be 1 to 3 m at the right abutment and around 1 m at the left abutment. As for the riverbed, it is estimated that a sound foundation can be obtained under the deposit.



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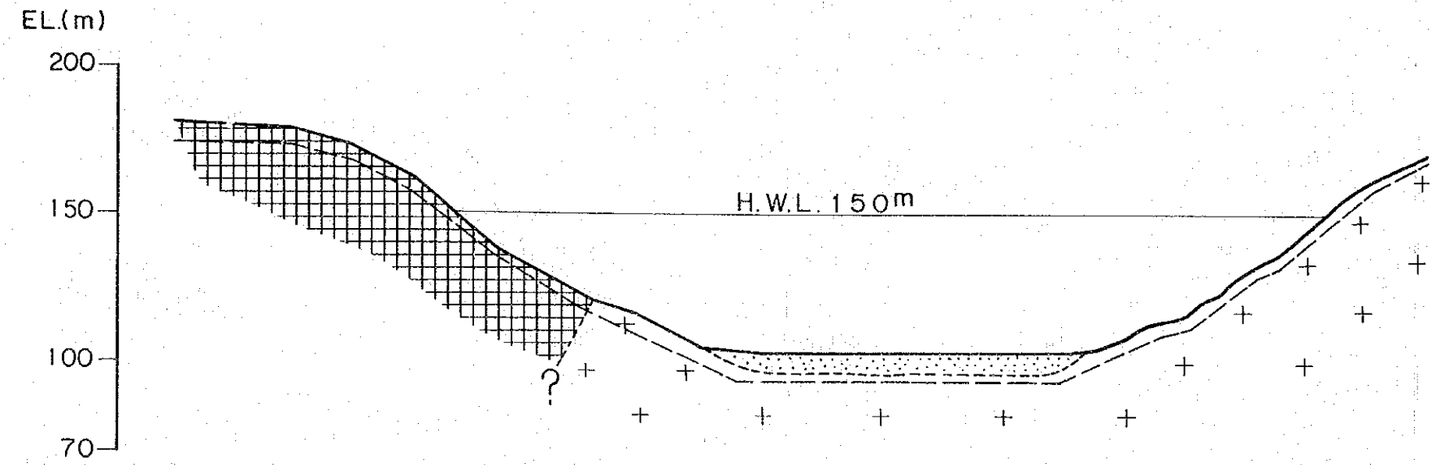


PROFILE

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Quartzporphyry
- Granite
- Sandstone
- Limestone
- Gneiss
- Schist

0 1.000 m
PLAN

0 100 m
PROFILE

GEOLOGY

20-64. MYEONGCHEON(明川)

Feb. 20. 1978 | Fig.- 24

3-21 Simcheon

(1) Outline of Project

Dam type: Rockfill
Dam height: 76.7 m
H.W.L.: EL. 170.7 m
Power station: Attached to the dam

(2) Topography and Geology of Reservoir Area

The reservoir is located on the Songcheon River, a tributary of the Geum River. The topography of the reservoir area may be broadly divided into two kinds resulting from the constituent geology. One is a topography characterized by prominent planation and waste-filled valleys seen in granite area, and the other is a mature topography of river terrace developed at meanders of river as seen in sedimentary rock area. The main river of this reservoir extends from roughly east (upstream) to west (downstream) while repeatedly meandering. The major tributaries located on the north side of the main river and their catchment area belong to the former topography, while the greater part of the main reservoir and the tributaries located on the south side of the main river and their catchment area belong to the latter topography. The former topographical area is stable as a whole whereas in the latter area rock falls are seen at many places where there are cliffs. Accordingly, taking the Simcheon River as a whole, it is a comparatively rought river.

Although geological investigations inside the reservoir area could not be carried out in the present reconnaissance, according to 1/250,000 geological map, the granite consists of the Neungju Group and the Jinam Group, while the two groups of the latter are comprised of non-calcareous rocks such as conglomerate, sandstone and tuff. Consequently, it is judged that there will be no problem of leakage at the reservoir area. As a further note, there are small-scale distributions of schist and phyllite in the vicinity of the damsite.

(3) Topography and Geology of Damsite

Topography

The damsite is located approximately 3 km downstream from Simcheon Myon, Bussam Ri. The river at the damsite area flows in a roughly straight line from northeast to southwest.

The right-bank abutment has a slope of about 30° and below the road immediately upstream of the dam axis there are river terrace deposits. The left abutment is a steep slope of 40° to 45°, and both the upstream and downstream sides of the dam axis show roughly the same topographical features. The width of the riverbed is approximately 140 m and an intake weir (submerged, height about 1 m) for irrigation has been built along the dam axis.

Geology

The basement rock at the left and right banks is comprised of schist and phyllite. The orientation of schistosity is roughly N50°E, 39°-40°SE (downstream side).

The left abutment is covered by a sparse grove of trees, but slope wash is very thin and rock is exposed over roughly the entire surface. Weathering is shallow in general, but openings along schistosity and irregular cracks can be seen.

The riverbed is covered by sand-gravel deposit and outcrops of the basement rock cannot be seen, but it is thought probably to consist of schist and phyllite similarly to the both abutments. The thickness of the river deposit is slightly large having been affected by dam-up for irrigation and is estimated to be around 5 m.

The right abutment as a whole consists of shist and phyllite similarly to the left bank, but along the dam axis, dyke rock of hard, dense amphybolite can be seen to a height of 5 to 10 m above the road. Schist distributed higher above is prominently weathered as a whole and is fissile. Further, talus deposits can be seen upstream of the dam axis.

(4) Geology of Appurtenant Structure Site

A concrete gravity dam is planned for this site and the power station is a dam type. The location of the powerhouse is presently undecided, but geologically, no problem will be involved at eigher the left or right bank. However, since the basement rock consists of schist and phyllite inclined toward the down-stream side and both of these rocks are prone to sliding, a location should be selected where excavation for the powerhouse will be of small scale insofar as practicable.

(5) Material

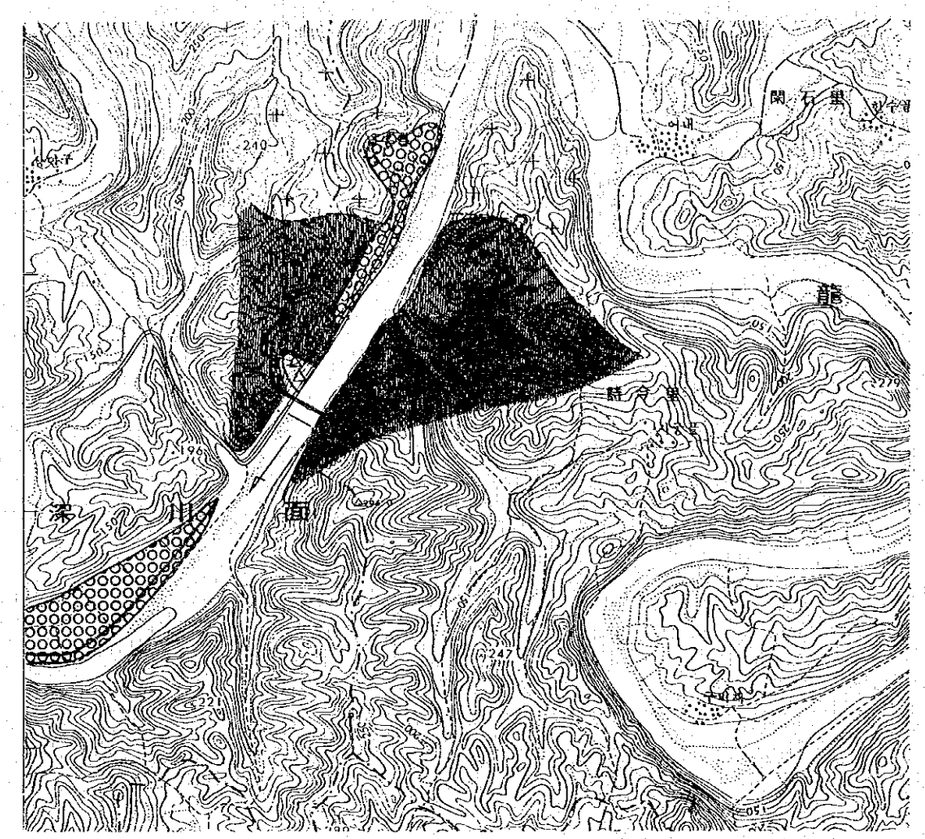
It will be possible to collect rockfill material from the natural deposit at the riverbed and quarry near the damsite. Impervious core material is not yet investigated on this time.

(6) Comments

A) The foundation rocks at the site will be of no problem in construction of the proposed dam.

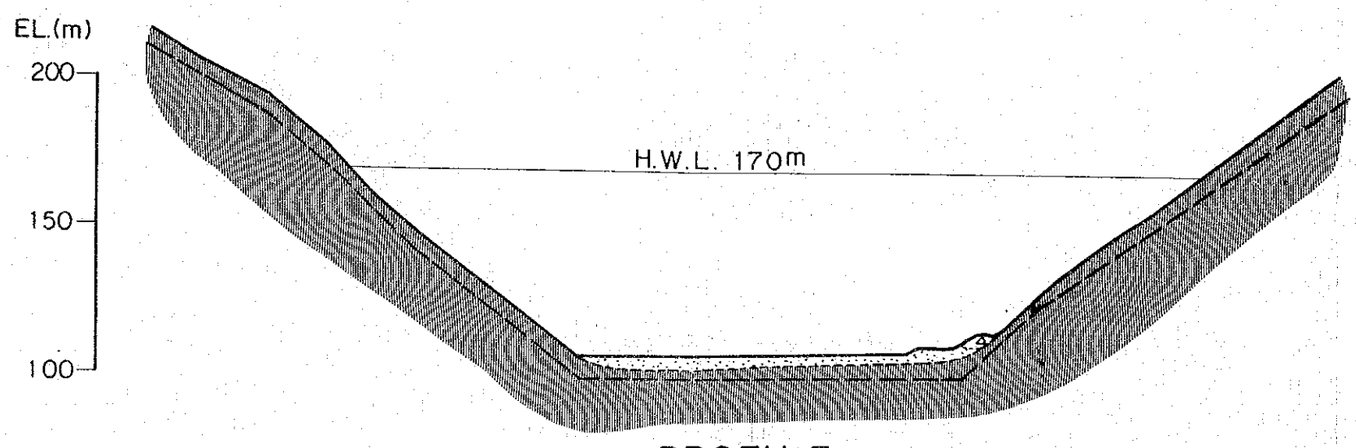
B) However, the foundation rocks at the right abutment have been somewhat severely weathered. It will be necessary for investigation to be made by drill holes. If practicable, it is thought better to move the dam axis in the downstream direction within a range of several tens of meters from the present axis.

C) Since the foundation rocks are schist and phyllite which are liable to show sliding, when a topographical map of the site has been completed, a more detailed field geological investigation should be carried out, and the results of the investigation referred to in selection of the powerhouse site.



LEGEND

- Talus
- Sand and Gravel
- Terrace
- Quartzporphyry
- Granite
- Sandstone
- Limestone
- Gneiss
- Schist



0 1,000 m
PLAN

0 100 m
PROFILE

GEOLOGY
21-69. SIMCHEON (深川)

Feb. 20. 1978 | Fig.-25

3-22 Jeokseong

(1) Outline of Project

Dam type: Rockfill
Dam height: 66 m
H.W.L.: El. 133.0 m
Power station: Attached to the dam

(2) Topography and Geology of Reservoir Area

The reservoir area is enclosed with gneissose granite, presenting hilly topography of mature and old stage. Valley plains with terraces are developed. There are two saddle ridges of El. 135 m on the right bank of the reservoir area. Determination of H.W.L. should be carefully done in relation of the height of these saddles. The saddle protions are deeply weathered and groundwater level is about El. 125 m. In case of H.W.L. is higher than the groundwater level, some countermeasure against leakage should be necessary.

(3) Topography and Geology of Damsite

Topography

A damsite is selected in the narrow channel between two granite hills in the southeast flow of the Jeokseong Cheon. Selection of dam axis is limitted within a hundred meter. Left bank slope is about 28° without relief. Riverbed is 100 m in width and bedrock is exposed. Right bank slope is also 28° accompanying some thick talus in its skirts. Proposed dam axis at present is drawn on the one of the talus deposits mentioned above. It is better to shift the axis toward upstream as far as 30 m.

Geology

The granite outcrop on the left bank is quite uniform texture with no fault. Upper part of the granite slope is covered with thin soil less than 1 m and weathered depth may be 2-3 m. Granite is exposed all over the riverbed. It is jointed but not fractured. Surface cutting of about 1 m will be enought to expose fresh rock foundation. Granite on the right bank is more jointy and there develops several talus on its skirts. Proposed dam centre at present is drawn on the one of the talus of 6-7 m thickness. It is recommended to shift the axis about 30 m upstream to avoid the talus portion.

(4) Geology of Appurtenant structure sites

Sphillway: Spillway can be laid on either side of the river. It will be build on firm base rock.

Power station: Power station can also be built on firm base rock on either bankside of the river, just downstream of the dam.

(5) Material

Impervious core material: Deeply weathered granite in the hill slope on the right bank, 500 m upstream from the damsite can provide necessary impervious core materials.

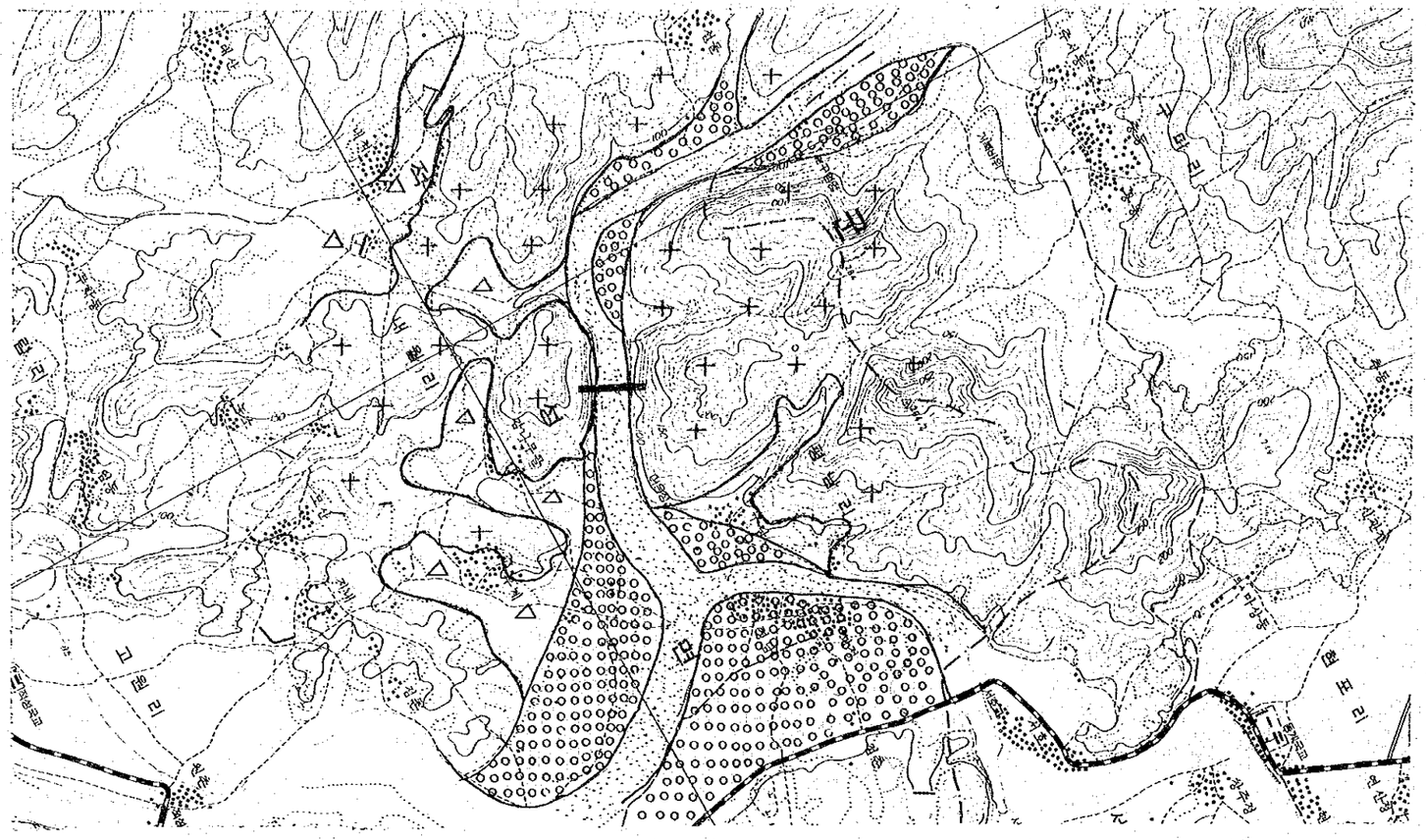
Filter material: There is no sandy deposits in the riverbed at the damsite. River terraces in the downstream reach are composed of silty material only. Filter material of coarse sand is not available in nearby area. Economical comparison of production by milling at jobsite and transportation of longer distance will be necessary.

Rockfill material: Granite hill on the right bank, one kilometer upstream of the damsite is hard and sound with thin covering. It can be served as a quarry to provide rockfill material.

(6) Comments

A) Granite rock is well exposed in riverbed and on both abutment slope, except some talus deposits covering a part of right abutment. Either rockfill or concrete gravity dam can be built directly on the sound granite rock.

B) Possibility of leakage of impounded water through a saddle ridge of El. 135 m on the right bank side of the reservoir, should be further studied carefully.



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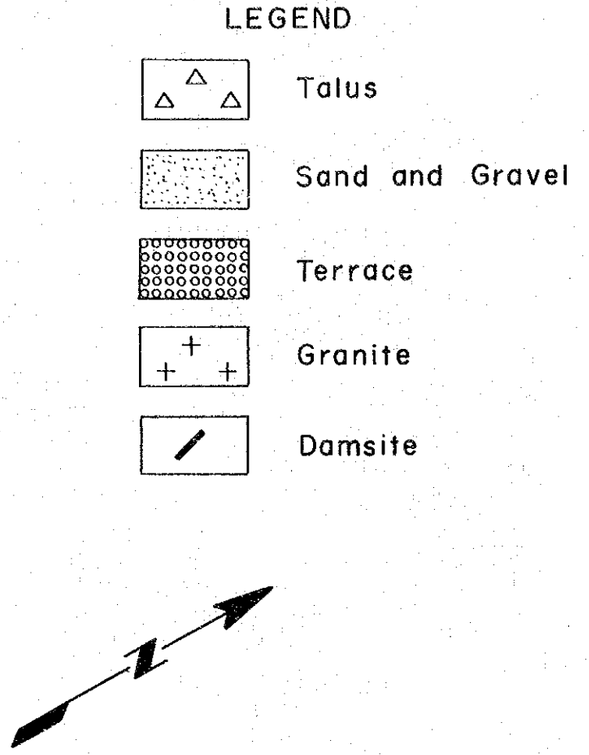
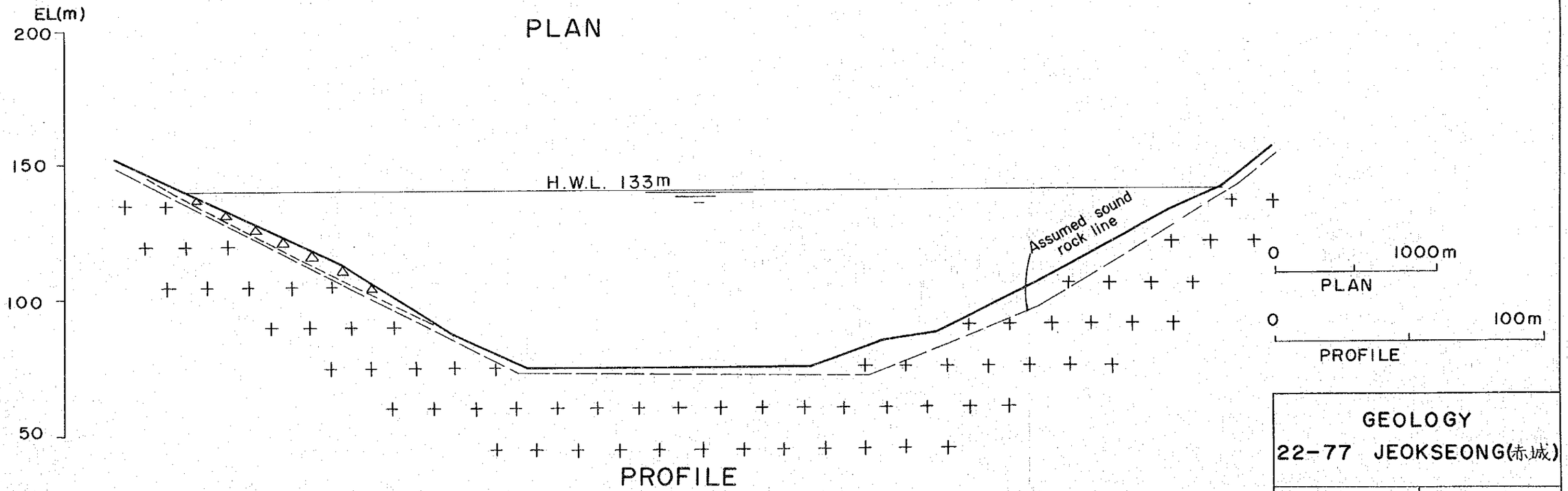




PROFILE

GEOLOGY

22-77 JEOKSEONG(赤城)

Feb. 27. 1978 | Fig.- 26

3-23 Juam

(1) Outline of Project

Dam type: Rockfill
Dam height: 76.5 m
H.W.L.: 124.5 m
Power station: Attached to the dam

(2) Topography and Geology of the Reservoir Area

The topography of reservoir basin is gneiss hills of mature and old stage. River valley is well dissected and develops a series of valley plains, mature and old stage of topography is well stable and there is no landslide or landslip in the area.

(3) Topography and Geology of Damsite

Topography

Dam axis is selected at northward straight reach in rocky hills of gneiss. The slope on the right bank abutment is about 37° with no gullies or relief. Riverbed is very flat having width of 140 m. The dam axis selected at present is on a talus slope on the left abutment. The axis should be shifted at about 50 m downstream where hard rock is exposed. The left abutment slope is about 35° and 22° at upper part above elevation 120 cm.

Geology

There are some talus deposits at the foot of hill on the left bank. Present dam axis is drawn on the one of the talus of 5 meter thickness. The axis should be shifted to a hard rock abutment, 50 m downstream. Most of the abutment generally covered with surface soil of about 1 m and weathered zone of 3 - 4 m thickness. There may be some small fracture zone at the water's edge.

Wide and flat riverbed is covered with cobbles and sand, having no outcrops of base rock. The thickness of the sediments may be 2 - 3 m. Topography shows no remarkable fault.

On the right bank abutment, gneiss exposes at water's edge and the slope is covered with surface soil of about 1.0 m thickness. Fresh gneiss

can be expected after excavating 2 - 3 m of weathered rock. No fracture zone is recognizable.

(4) Geology of Appurtenant Structure Site

Spillway: Spillway can be constructed on hard and sound base rocks on either side of the river.

Power Station: Power station can also be built on either side of the river just downstream of the dam, after shallow excavation of sand and gravel. Slope behind the power station is quite stable against landsliding.

(5) Material

Impervious core material: There is no borrow area to produce impervious core material nearby the jobsite. There may be some possibility to find out weathered gneiss in the low hill area on the left bank, several kilometer downstream.

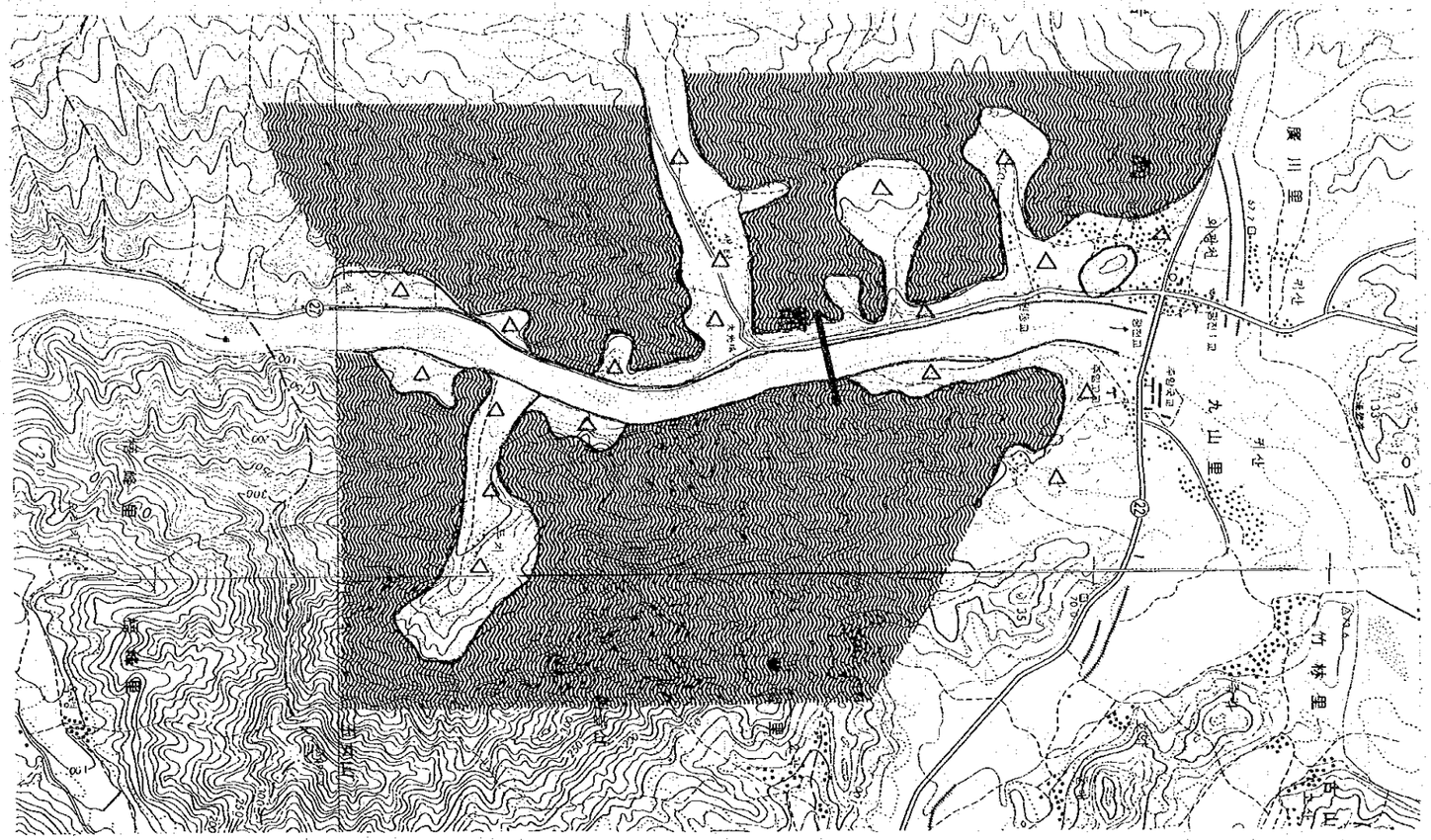
Filter material: No suitable filter material can be expected in the nearby area. Economic comparison should be studied between supply from distant borrow area and production by milling in quarry site.

Rock material: A quarry site is promissing to locate at hill side gneiss, 1000 m upstream of left tributary. The gneiss body is thinly covered with surface soil and fresh and hard gneiss is expected underneath.

(6) Comments

A) A small scale fracture zone can be expected along left bank. Riverbed is flat and wide being covered with rather thin gravel layer. Rockfill dam can be built on the fresh and sound base rock.

B) Further investigation to find out a borrow area for impervious material. Wide area reconnaissance over the upstream and downstream is necessary.



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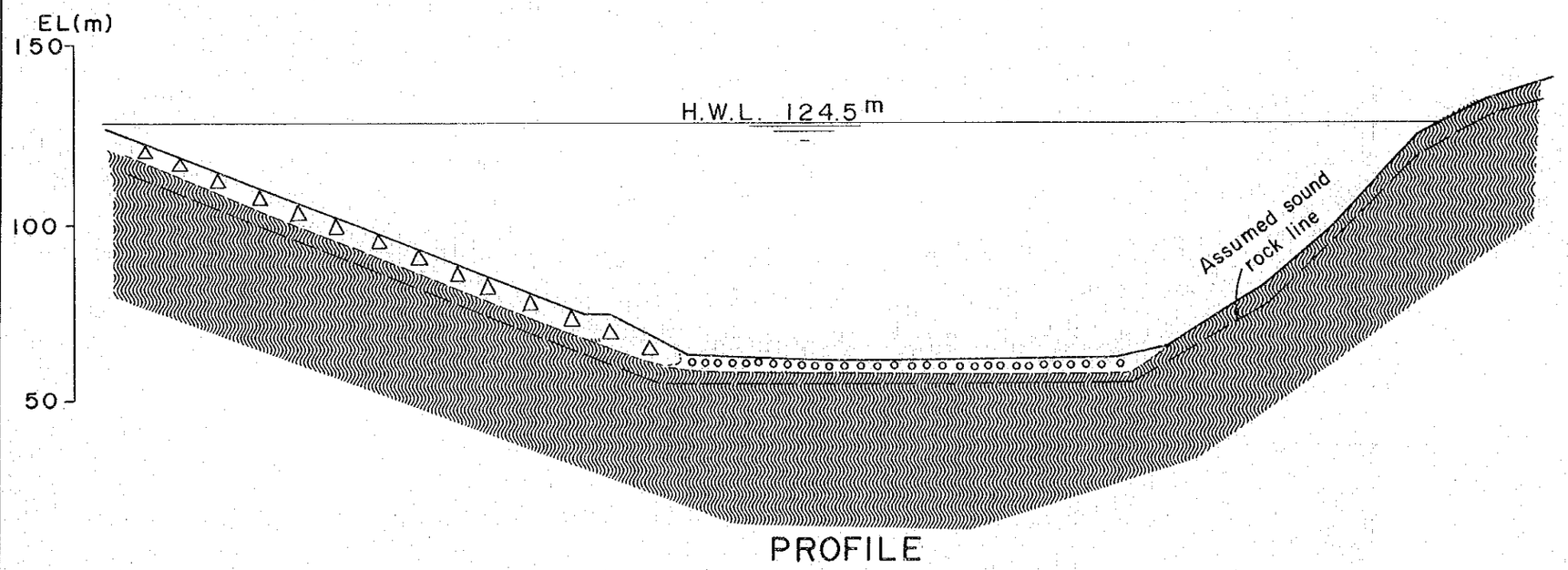


PROFILE

LEGEND

- Talus
- Sand and Gravel
- Gneiss
- Damsits

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY
23-82 JUAM (住岩)

Feb. 27 1978 | Fig. - 27

3-24 Boseonggang No. 2

(1) Outline of Project

Dam type: Rockfill
Dam height: 25 m
H.W.L.: El. 119 m
Power station: Attached to the dam

(2) Topography and Geology of Reservoir Area

The reservoir area consists mostly of granite gneiss hills. It comprises topography of old stage having extensively cultivated valley plains. The basin area is well-reforested. No landslide topography in the area. There is a saddle ridge in the extension of the right bank ridge, though its altitude is sufficiently higher than proposed high water level.

(3) Topography and Geology of Damsite

Topography

A damsite is selected at a narrow channel between dissected gentle hills. Rather steep slope of 33° is standing on the left bank. Riverbed is 110 m. in width and covered with thick gravel deposits.

On the right bank, base rock is exposed only at water's edge and the slope of 30° is covered with talus debris. The slope is extending eastward forming thin ridge with an altitude between El. 160 - 170 m. Thus the location of right abutment of dam is limitted in narrow range. Riverbed gradient is very gentle, providing large storage capacity with relatively low dam.

Geology

On the left bank slope, an outcrop of granite gneiss is found at a road cut. Surface soil and weathered zone of the granite gneiss is rather thin. Dam body can be abutted directly on fresh gneiss after shallow excavation. A fault with fracture zone of 5 m width is crossing at upper part of the slope.

Flat riverbed is covered with thick gravel and cobble. Thickness of the gravel deposits is supposed to be 3 - 5 m. Base rock of granite

gneiss is expected underneath. Right bank slope consists of granite gneiss with aplite dyke. The slope is covered with thick weathered zone and talus debris. Thickness of these overburden is estimated at about 10 m. Granite gneiss is exposed again on the thin ridge.

(4) Geology of Appurtenant Structure Site

Spillway: A spillway should be laid on the left bank slope, because sound rock foundation can be exposed by shallow excavation.

Penstock and power station: Penstock and Power station will be laid on the opposite bank close to the dambody. Power station can be built on sound base rock after removing weathered overburden and talus. Penstock line will be laid on the deeply weathered slope. Special devices will be needed for anchoring of the pipe line on the poor foundation.

(5) Material

Impervious core material: Impervious core material can be expected at deeply weathered zone on the gentle slope of granite gneiss in a small tributary on the right bank, 1500 m upstream of the damsite.

Filter materials: No sandy material is available in the riverbed nearby. Wide area survey is necessary to find out sandy deposits in the river channel.

Rock material: A steep cliff exposed granite gneiss is found in the small valley on the right bank side, 500 m. upstream of damsite. A quarry can be opened in the valley.

(6) Comments

(A) A series of wide valley plains are developing in the reservoir area and these plains are well cultivated and inhabitted. Bigger compensation will be demanded against submergence under these circumstances.

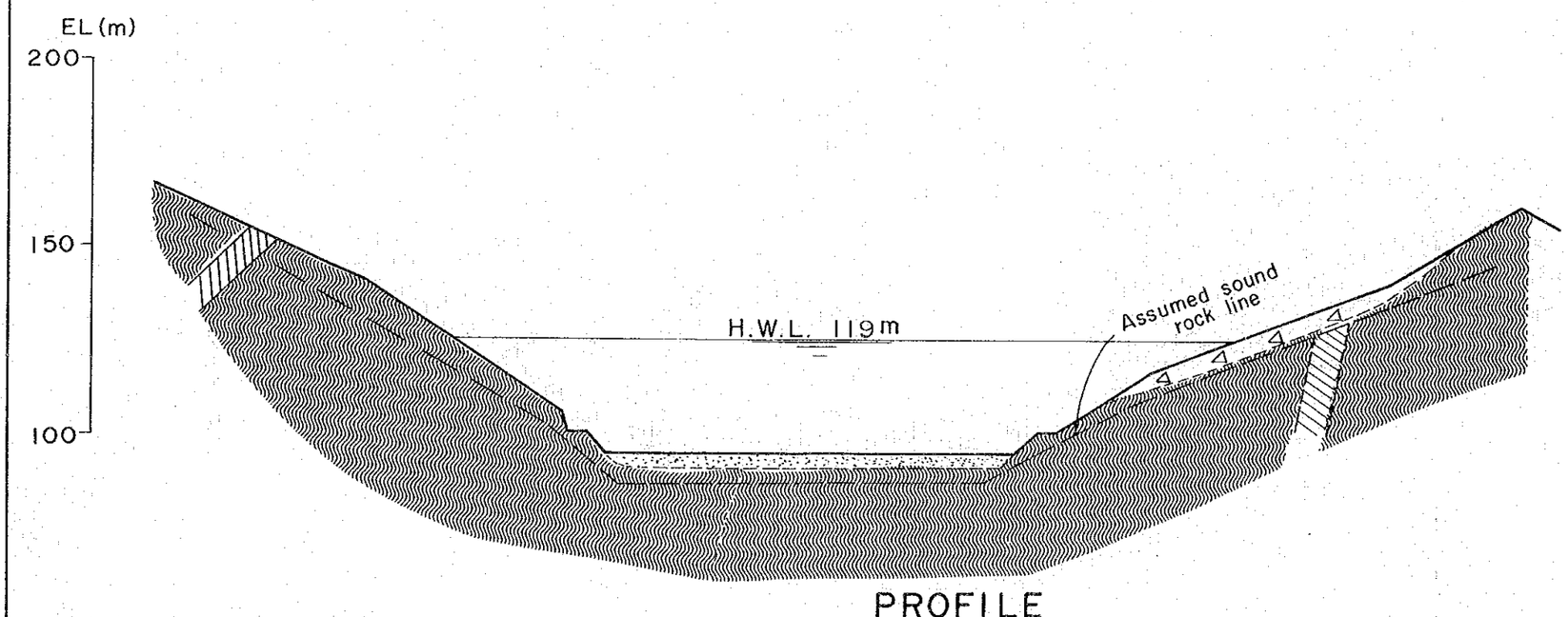
(B) Height of dam cannot be raised, because foundation condition is not favourable on the right bank abutment.

(C) It is necessary to confirm the depth of fresh rock line on the right bank slope by means of test adit.

PLAN

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Gneiss
- Sheared zone
- Damsite



PROFILE

0 1000 m
PLAN

0 50 100m
PROFILE

GEOLOGY
No.2 BOSEONGGANG
(第二宝城江)

Feb. 27. 1978 | Fig.-28

4. ESTIMATE OF SEDIMENT YIELD RATE

4. ESTIMATE OF SEDIMENT YIELD RATE

As river water in the upper and the middle reaches in Korean is normally clean with little or almost no suspended materials in low water level, it is assumed that sedimentation in the reservoir will be caused with bed load and in time of flood.

No existing data of bed load was available at the proposed dam site in this study or even if it is available, the data involves commonly uncertain. Therefore, sediment yield rate is inevitably to be estimated with a statistical method concerning the actual sedimented volume of the existing reservoir.

4-1 The Measured Sediment Volume of Existing Reservoirs

It was informed that sediment volume had been measured on existing reservoirs of Hwacheon, Cheonpyeong, Boseonggang, etc. long years ago, however, the data could not be obtained at this moment, because most of these data was missing.

Only the sediment yield rate of 281 $m^3/km^2/year$ in Cheonpyeong dam reservoir has been taken to many reports of dam construction projects of Seoyanggang and Yongdam for estimated of sediment volume.

Another Korean report concerning Geum river basin development project referred to the measured sediment volume 423 - 1136 $m^3/km^2/year$ on ten existing reservoirs with catchment area of 1.2 to 14.8 km^2 which had been made more than 12 years before to measurement for the estimate of sediment yield rate of that basin.

4-2 Adopted Sediment Yield Rate for to Recent Dam Construction Project

The following estimated sediment yield rate was adopted for the recent dam construction projects.

Dam	Estimated sediment yield rate ($m^3/km^2/year$)
Namgang	414
Seoyanggang	500
Andong	519
Daejeon	300
Chungju	800
Hapcheon	700

At some project dam sites, the bed load and suspended load was measured, however, it was known that the measured result was in wide variation.

4-3 Statistic Analysis Based on Topography

As mentioned before, the sediment mechanism, that is mainly caused with bed load in flood time, is assumed to be similar to that in Japan.

The studied dam sites in Korea are located in mountain region of topographycally matured or old stage formed mainly of granite gneiss and granite. This topographic character and yearly amount of rainfall will be similar to the Kinki and Chugoku region in Japan.

A Tanaka's formula for that region, which was statistically introduced with a number of existing sediment yield data, may be applied for estimate of sediment yield rate for the proposed reservoir.

As due procedure, undulation value and average altitude that is the difference of the highest and the lowest elevations and average of them respectively were read in each 4 km x 4 km quadrangles in the catchment area of the proposed dam on 1/50,000 scale map. The calculation result is shown in the following table.

CALCULATION OF SEDIMENT YIELD RATE

Damsite	Catchment area km^2	Undulation (100m)	Altitude (B) (100m)	(A)x(B)	Sediment yield rate ($m^3/km^2/y$) Most probable	Upper limit	Safety factor	Estimate
Bamseonggol	583	No map is available upstream, refer to Hupyeong						
Hupyeong	305	5.49	8.78	48.20	367	436	1.5	654
Inje	1043	5.45	8.30	45.25	354	423	1.3	550
Woelhak	563	No map is available upstream, refer to Hypyeong						
Hongcheon	1473	4.42	4.72	20.86	244	313	1.3	407
Gujeol	101	3.52	8.90	31.36	291	360	1.5	540
Pyeongchang	485	5.14	8.75	44.95	352	421	1.5	632
Panun	652	5.17	8.32	43.02	344	413	1.5	620
Suju	329	4.14	7.53	31.17	290	359	1.5	553
Degog	493	4.02	6.66	26.75	270	339	1.5	509
Dalcheon	1348	4.09	4.23	17.29	228	297	1.5	446
Ganhyeon	1180	4.26	4.57	19.47	238	307	1.5	461
Bonghwa	1105	4.84	7.56	36.59	315	385	1.3	501
Imha	1230	3.51	4.88	17.15	227	296	1.3	384
Chibo	4550	3.18	4.04	12.85	208	277	1.5	416
Hamyeng	264	5.61	8.54	47.92	353	435	1.5	653
Dogsan	231	6.09	7.40	45.18	366	422	1.5	633
Yongdam	949	4.66	6.23	29.03	281	350	1.3	455
Sutong	1526	4.80	6.24	30.00	285	354	1.3	460
Myeoncheon	2003	4.48	5.66	25.35	264	333	1.3	433
Simcheon	640	4.05	4.74	19.20	236	305	1.3	397
Jeokseong	x241	4.32	3.91	16.89	226	295	1.3	384
Juam	x735	3.95	3.70	14.63	216	285	1.3	370
No.2 Boseong-gang	x182	3.55	3.25	11.53	202	271	1.3	352

Applied formula; Tanaka's formula C group for mountain area composed of metamorphic, plutonic and intrusive rocks in Kinki and Chugoku region in Japan

$$y = 4.5x + 150 \ (\pm 69)$$

where y: sediment yield rate, x: (A) x (B)

x excluding catchment area of the existing upstream reservoir.

Comparing the calculated value on Hongcheon with the measured sediment yield rate, 281 m^3/km^2/year in Cheonpyeong dam reservoir, which is located nearby, the sediment yield rate in Korea will be nearer to upper limit rather than to the most probable value in Japan.

4-4 Planning Sediment Yield Rate

The river basin in Korea is becoming stable due to intense reforestration and preservation in hilly area. However, it is better that sediment yield rate in Korea is estimated to be 130 - 150 per cent of that calculated rate of the upper limit in Japan, because the mountain area of the catchment area, especially hill masses of weathered granite showing bare slopes, seems to be more unstable in Korea than those in Japan.

The sediment yield rate to be adopted for the proposed dam reservoirs are given, as follows, by rounding the estimated upper limit values considering safety factors of additional 30 per cent for the stable catchment areas having rich forest in it and wide valley plains upstream in long main river channel, and additional 50 per cent for other catchment areas.

SEDIMENT YIELD RATE TO BE ADOPTED

Sediment yield rate (m^3/km^2/year)	Dam
700	Bamseonggol, Hupyeong, Weolhak, Pyeongchang, Panun, Hamyang, Dogsan
600	Inje, Bonghwa, Gujeol, Suju, Dogog
500	Hongcheon, Ganhyeon, Dalcheon, Chibo, Yongdam, Sutong, Myeongcheon
400	Imha, Simcheon, Jeokseong, Juam, No. 2 Boseonggang