REPORTS OF GEOLOGICAL SURVEY
FOR
CIVIL ENGINEERING WORKS

1981

JAPAN INTERNATIONAL COOPERATION AGENCY
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Reports of Geological Survey for Civil Engineering Works compiled by Kazuji Uno, Expert on Engineering Geologist dispatched by the Japan International Cooperation Agency (JICA) to the Republic of Indonesia under the Colombo Plan Technical Cooperation Scheme (dispatched duration: from July 1974 through July 1980).

REPORTS OF GEOLOGICAL SURVEY FOR CIVIL ENGINEERING WORKS

NOTES ON THE GEOLOGIC - SOIL MECHANIC REPORT OF INDRAPURA PROJECT, WEST SUMATRA

K. Uno
Feb. 2, 1980

1. Borrow area

The location of borrow areas must be shown on the map, which is connected with geological distribution of each layer. Also the trend of distribution (or depth) of each materials must be written in the text. And from these data, estimation of avialable volume of each materials must be indicated in the text. These data are necessary for planning of excavation and transportation work of materials.

2. Summary list about soil test

The form of summary of soil test is not enough. If the sampling condition or test condition of materials are not clear, these values are almost meaning less to evaluate the properties of materials.

3. Properties of each zone of dyke

Picking position and quantity of materials and how their representative design parameters are conducted from many test values are necessary to be written. If not so, the readers can not appraise the design parameters.

For instance, on this zone type dyke, the core is easily supposed as silty soil on the terrace, but the properties of transition zone and rock zone are not clear. Though the transition may be supposed to river bed gravel from its design parameter $K = 3.4 \times 10^{-3}$ cm/sec, is it proper or not?

4. Depth of foundation

There is not shown so clear the grounds to decide the depth of excavation. The deposits of river side and river bottom are often different. As example, see the reports (Lamp. 2, 1955 and Lamp. 2 P.R. 2, 3, Page 21, 1977)

5. Thickness of pervious layer under the river

On the note of design calculation, 75 m is thought as the thickness of pervious layer. But this is only the maximum explored depth of geo-electricity. In my opinion, it is recommended to take 10 - 20 m due to its relative electric resistivity.

6. Piping

On the examination for piping, adopted values as specific gravity and void ratio (i.e. unit weight) are the ones taken from river side deposit and it is doutful to use as the one of river bottom deposit.

7. Pore pressure

THE SUGGESTION ON GEOLOGICAL AND SOIL MECHANIC VIEW FOR SELUMA CLOSING DYKE, BONGKULU PROVICE

K. Uno

Jan. 22, 1980

This suggestion corresponds with the one that discussed in the last meeting of Nov. 9, 1979. After the meeting, we carried out some supplemental surveys. But they could not be sufficient under those circumstances. Taking the demand for urgent construction into consideration, unsolved problems must be decided on the way of operation. It may possibly occur to change the designs. On such sense, the following considerations are necessary (paragraph number corresponds with the number adopted in the last suggestion).

(I) Geology

(1) River deposit

The shape of trench cutoff section may be changed, consequently the excavation volume also may change in some degree. Remarking in passing, the site of cutoff may be changeable.

This time, permeability test show $K = 8.6 \times 10^{-2}$ and 8.2×10^{-3} cm/sec. These value may be adoptable for calculation of dewatering or seepage volume.

The grain size distribution of the river deposit (sandy gravel) became clear. This is available to know the character of filter.

The apparent specific gravity (not yet be calculated) can also be used to examine the piping.

(2) Terrace deposit

The charactors of dumped soil (2-1) are as follows. N - value = 9.9, 4, 7, 4 i.e. weak. Permeability coefficient $K = 7.95 \times 10^{-4}$ cm/sec i.e. semipervious. Grain size = sand 60%. Therefore, it needs to examine the replacement of materials.

The name of clay and silt layer (2-2, 4) were changed to silt and silty sand after the new survey. Permeability coefficient $K = 4.2 \times 10^{-5}$ cm/sec. N - values change from 8 to 30 in proportion to the depth. Therefore it needs to decide the excavation depth of foundation corresponding to their allowable bearing capacity.

Permeabilities of gravel layer are $K = 3.24 \times 10^{-3}$ and 6.8×10^{-4} cm/sec i.e. pervious and semipervious. The concern and its countermeasure for seepage and piping through this layer will be able to examine by the existing data of grain size distribution and apparent specific gravity.

(5) Sand stone layer

Permeability test shos again $K = 5.5 \times 10^{-4}$ cm/sec at this time. But it perhaps happens under abnormal rock condition. In my view, ordinal sand stone is impervious and has sufficient bearing capacity as the base rock.

(II) Soil mechanics

As mentioned at the last time, fill materials is M H (by unified soil classification), and not always suitable to operation, and the grain size distribution indicates that they are in danger of crack occurring. Then I suggest to study the gravel layer lain under the M H layer at the borrow area, but my intention seems not to be understood. There is still possibility to get better materials at borrow area, if the grain size distribution of this layer is almost the same as the gravel layer at damsite.

Remarking in passing, the rising drain (intercepter) is generally recommended for homogeneous type fill dam.

THE QUESTIONNAIRE ON THE GEOLOGIC-SOIL MECHANIC REPORT OF INDRAPURA (1975, 1977, 1978) WEST SUMATRA

K. Uno
January 11, 1980

I. Geology

1. The relation of investigation points and construction in general map (L2, 1975)

2. Sand and gravel layer and impermeable layer

   a. Quotation book of classification of layer in the analysis of geological data (P.23, L3a, 1975)? It's very interesting.

   b. Difference of geo electric classification from 1975's report. (especially wheathered breccia and alluvial deposit (P.33, 1978)?

   c. The reason of difference of boring core boundary and geo electric boundary. DH 3 = R 7, DH 4 = R 6 (L.II 1978), DH 1 = R 2, DH 2 = R 6 (L.11A 1978)

   d. Difference between (DH 2 and 4, 1977) and excavated outcrop (L.2, 1977)?

   e. Method of identification of alluvium (river deposit) and weathered volcanic breccia?, detaile discription of core log?

   f. Difference between (DH 5, L.2) and (log 3-2. 1977) L 2 might be correct.

II. Permeability

   a. In generally speaking, the difference of electric reistance (ρ, ohm/m) of 10^2 order and 10^{0-1} order often show distinct difference of premeability. (for example ρ_{94} on DH 1, ρ_{50} on DH 2, ρ_{58} on DH 4 L 11, L IIA, 1978).

   b. Core recovery is 100% and permeability coeff. 10^{-3} cm/sec ? (DH 5. 1977)

c. Detail of permeability test specification?

III. Borrow area

a. Soil material of 150,000 m^3 is required to show the extent of capable borrow area and ground of calculation on volume.

b. The difference between borrow pit B.P. 1-10 (L.I. 1977) and B.P. 1-6 (L.I. 1978)?

c. Description of test pit is very clear (for example MH, SM, GW etc.). Were they identified by naked eyes or sieving? (L 3a 1975, L.V. 1978)

d. Its better to test the sand gravel (so called alluvium deposit) about grain size distribution, unit weight and permeability by test pit.

IV. Soil test

a. The purpose of water content test at 2 location in a borrow pit (L.IV 1978)

b. How to introduce the design parameters? (P.29. 1975, P.29. 1977, P.43. 1978). The relation to the parameter of 1979?

c. Are there any authorized criteria or general opinion about the analysis of slope stability for dyke or dam in Indonesia?

Total stress C ø (1977)
Effective stress C' ø' (1978)
The other which adoptable parameters as pre pressure or seismic coefficients etc.

d. Questions about summary of laboratory test (L.10 1975, app. 7-a 1977, L.V. 1978)

V. Design

a. Piping
b. See page
c. Filter

} Blancket (P. 7-12. 1979)

VI. Refference book

If possible, I wish to see the original of followings.

a. Estimation of q all from N-Value (Teng: Foundation design)

" from qc (?)

application of graph (P.20, P.25 1977)

b. Calculation of slope stability (Taylor: Fundamental of soil mechanic) (P.28 1977)

c. Calculation of see page (N, Parlooski P.9 1979)

d. Geo electric data (ρ-a curve) (1975. 1978)

THE PROGRESS SITUATION OF GEOLOGICAL-SOIL MECHANICS SURVEY OF SELUMA CLOSING DYKE, AT OCTOBER 1979 and the SUGGESTIONS

K. Uno

Nov. 7, 1979

(I) Geological survey (see a appended figure. Following sub item numbers are correspond to the signes in figure)

(1) River deposit

The rough section at the dam axis was shown by boring DH 7' and DH 9. But take care of that this section may not be the same as the trench cut off section at the toe of dyke.

This river deposit is thought to be consisted of sand and gravel, but the coef. of permeability tested by boring DH 7' was described at 10^{-4} cm/sec. In Calculation Note, $K = 10^{-2}$ cm/sec was used. As this value is important to calculate the seepage volume, dewatering volume or blanket length etc., the value must be reexamined.

If the permeability test is not easy by the way of boring, it may be one way to dig the test pit in the dry river deposit and adopt the pumping up method.

To study the grain size distribution of river deposit is also important for calculation of creep ratio, blanket length or base filter (if necessary). After digging test pit, the way of sampling is the same as the case of sieving of concrete aggregate. Take care not to miss the fine particles, as the samples pick up from the ground water.

(2) Terrace deposit

The top deposit (2)-1 at boring DH 1, thickness of 5 - 6 m, was described at top soil last time, but it is now said as excavated dumped soil. This soil may not be able to distinguish from silt and clay (2)-2' in boring DH 8.

The engingeering character of gravel layer (2)-3 at boring DH 1 is not known yet. If this layer has high permeability, it might need cut off wall jointing to dam body.

On the left side, gravel layer (2)-3' is found out newly. The relation of these gravel layers between (2)-3 and (2)-3', and between clay layer on left side (4) and silt and clay layer (2)-2' on the right side are not clear geologically.

The distribution of these layers at dam site must be made to clear and not to be estimation as far as possible. Then, it is recommended to make it a rule to make trench of 1 - 2 meters depth along the dam axis by bulldozer or man power at the survey of dam geology.

Engineering characters of these foundations such as bearing capacity, permeability or grain size distribution are not clear yet. It seems easier to study them by using test pit in the trench or adit.

If the gravel layer (2)-3 and (2)-3' are pervious, they must be pursued toward up and downstream area by outcrope or trench survey.

(3) Terrace deposit

Soil of this upper part of terrace on left side was considered as dam materials last time.

(4) Clay layer

Last time, it was considered as clay stone of tertiary deposit and has engough capacity, but now it is not sure by finding of gravel layer (2)-3'. This layer showed that N-value was 9 by standard penetration test.

(5) Sand stone layer

Despite the Coef. of permeability of 10^{-4} cm/sec about this layer tested by boring DH 7', the layer is seemed to be more impervious. In the Calculation Note, $K = 10^{-6}$ cm/sec is used. The bearing capacity are always shown as more than 60 blows by standard penetration test. Then, this sand stone may not arise much problems as the base rock of this dyke.

The practical procedure of permeability test by boring, however, msut be examined.

(II) Soil mechanic survey

The borrow areas are selected at new locations in this time and the results of laboratory test are not submitted yet.

But the available volume of banking materials is said to be more than 500,000 m^3.

The newborrow area are almost the same height as the first borrow area (3) and estimated to deposit under the same geological condition, so imagined to have almost same character. If so, the soil character may be MH or CH (silty or clayey soil, according to Unified soil classification). If soils are MH or CH, their shear strength is weak, compression is large in saturated condition and operation is comparatively difficult. The adequate consideration about soil handling might be necessary.

The body materials seems to be enough, but other materials such as sand, gravel or rock for filter and riprap are also necessary to conform their borrow areas, volumes and qualities in advance. These volumes may not be so small, if the design requires drains, intercepter drain, base filter and riprap filter etc.

(III) Questionnaire

(a) Coefficient of permeability of dam body (II 13.32)

$K = 2 \times 10^{-7}$ cm/sec

(b) Shear strength of dam body (II 13.42)

Internal friction angle	$\phi = 6^0$
Cohesion	$C = 0.6$ kg/cm^2
Saturated cohesion	C sat = ?

(c) Settlement of foundation (II 5, 1-4)

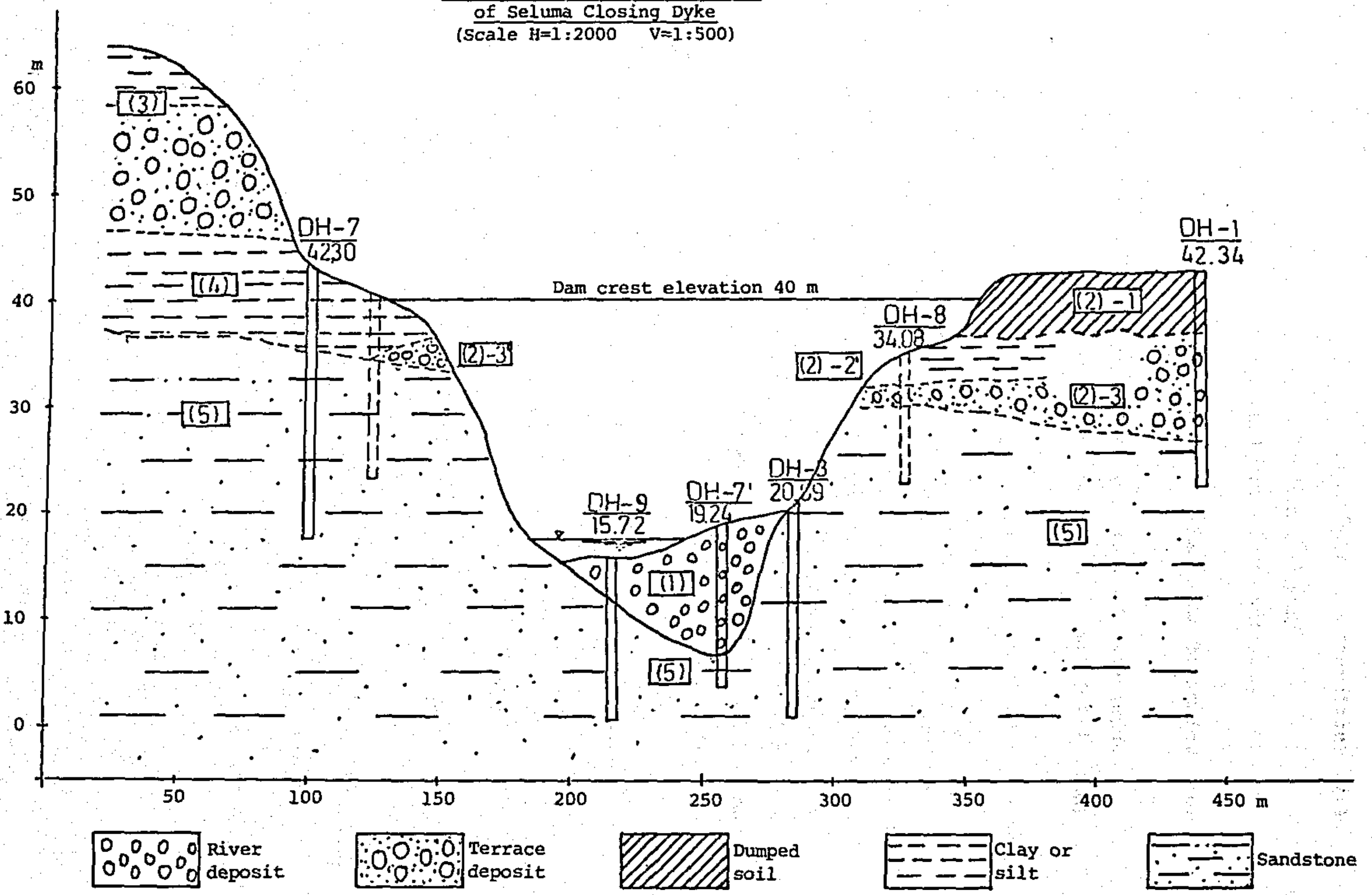
Compression index $Cc = 0.06$

Coef. of consolidation, void ratio etc.

(d) Volume of materials (III 17)

About the above design values mentioned in Calculation Note (Oct. 1979), the explanation of reference data is required.

The Geological Sketch Section
of Seluma Closing Dyke
(Scale H=1:2000 V=1:500)



REVIEW OF THE REPORT OF SOIL MECHANIC AND GEOLOGICAL SURVEY OF CILIMAU (D) WEIR SITE, TELUK LADA PROJECT, LEBAK, WEST JAWA. (23 NOV., 1978 P.T. WIRATMAN & ASSOCIATION CONSULTING ENGINEER)

K. Uno
Sep. 3, 1979

1. About the text

Page (2-10) Field work. About the discription of each exploration methods, their purposed and reasons for disposition have to be written. The purposes of samplings also need to be explained. To make ease the reader's examination, appendix numbers must be added for each explanation.

(3) There is no explanation about ground water in the text. What is the reason of water level difference between DH 1-3 and DH 4?

(9) Meaning of percolation test?

(11-12) Labolatory test. The appendix No. for the summarized list or illustrations of test are required.

(13) The dimensions of structures are better to write at the beginning part of text. Things necessary for geological and soil mechanic consideration must be shown.

(16) The relation of flood plain, flood level and river bank etc. is better to indicate numerically as far as possible, or relating the river bed height or average riverwater level.

Explanation of soil units is difficult to understand. The coincidence between text and att. 2 is necessary (e.g. unit name, unit number).

(17) The relation among soil/rock boundary, farm face and uncomformity (att. 2) must be explained and be described about the general results of petrographic study. There is no words about calcareous sand stone.

(18) The bounds of borrow area are not shown. Then there is no way to asses the volume of fill materials. Rough estimation of required volume of fill must be considered before survey. Whether the excavated soil from new river route will be used as bank fill or not?

Not only T.P. No. please show app. No or att. No. There is no discription of borrow area condition (e.g. natural condition condition, ground water, haulding distance etc.)

(19-21) Write att. No. and app. No. of the reference table or test illustration. It is better to write by elevation height instead of depth of soil layer (in the table) for refering the att. 3. 4. 13. Add the description along the level site table for explanation of att. 13.

(23) Borrow material. Please write att. No. and app. No. of reference tables. There is no report about the results of compaction test, natural moisture content etc.

(25) Stability of bank. Is the safety factor formula right? What are the weight friction angle (ϕw) and the developed friction angle (ϕd)? How was the soil condition (C, ϕ, γ) assumption induced from?

(27) How was the C, ϕ induced from? Which formula was used to calculate the utltimate bearing capacity?

(28) What sort of formula was used to calculate the ultimate settlement in about four years?

(30) About the condition that cause the weir stability, is it impossible to express quantitatively?

(31) How much is unit weight (1.75 g/cm^2 on P25)? Isn't it allow able on base of 8 kg.f./cm^2 (page 32, relation between qc (40 kg.f./cm^2) and allowable bearing capacity (1.10 kg.f./cm^2))

(33) As the lower table is convenient to estimate the slope gradient of bank from the characteristics of foundation basis, it must be inquired about its source. (What is the

precise meaning N-Value within foundation on the depth equal to height of embankment. How is the idea to decide the excavation depth). The relation between upper and lower table? You are better to examine the basis of levee of Ciliman D site.

(36) Provide the Indonesian loading coad of 1971 and comparison table between magnitude and Richter scale.

(37) Provide life time of structures in Indonesia. Doesn't the seismic risk analysis included in the loading code.

2. About the appendix.

Att. (1) Att. must be standardized to appendix or something. Att. (1) is only original map of att. 2. How about do you think to display settlement, bridge, road or newly recommended structures (page 34 in text). Put in the elevation height of contour more clearly.

(2) Display the external shape of weir, levee, new river rout, channel (they are all right ones on the stage of first planning). Difference the explanations between text (page 17) and legend (III and unit 3 in att. 3)?

Lack of T.P. 1 - 4, S. 1 - 2. and the indication of borrow area. Are the geological mapping is too rough? Doesn't the II unit exist at southern hill? Soils of T.P. 6 - 10 belonged to the III unit?

(3) Display the external shape of structure (crest and base of weir, levee crest height water level). Lack of legend of soil of rock (different from att. 4). Farm face. Boundary or units. Disirable to put signs at sampling positions (e.g. *undisturb **disturb ***petrological).

(4) Mistake of horizontal scale

(qc kg/cm^2 = corn resistance) are considered to rather small against N-Value (S.P.T.) (qc kg/cm^2 = (3-5) N in Japan)

(7) Geological drilling log

Put in the Petro logical sampling position (discription of app. 24 is mistake? on att. 7.e)

Write in the text about the consideration study of ground water (description miss? on att. 7.e)

The definition of drydrilling, water flash drilling, and normal of water circulation loss (is generally shown by % roughly)?

(8) Log of hand bore.

Is the disturbed sample all mixed sample or not?

(10) Sketch of trench. What is the purpose of trench and what is the relation of soil units?

App. (14) on 14a, B, the prefix of name of sample is better to use H.B., On 14 d.c. the meaning of same sample.

(15-17) Such lists are better to move to the end of text.

(15) Is better to show soil classification in Remark (if possible). On 15e. the necessity of measurement of Gs. Wn in disturbed evaporated sample?

(16) On 16h, What is G in the column of boring No.?

(19) The procedure to get Pc, Po, Cc is different from Casagrande's method. I want to know the source of method.

(21) There are no discription about drainage and consolidation.

(22) Explain the purpose of direct share test and correlation of triaxial compression test.

(23) There is no summarized list of compaction tests. Isn't it necessary to write γw?

(24) Write the sampling position on (att. 7). There is no saying about the calcareous sand stone in the text.

COMMENT ON THE REPORT OF GEOLOGICAL AND SOIL MECHANIC SURVEY OF CLOSING DAM OF AIR SELUMA PROJECT, BENGKULU PROVINCE. (FINAL REPORT, JUNE 1978, CV TRIDJAYA).

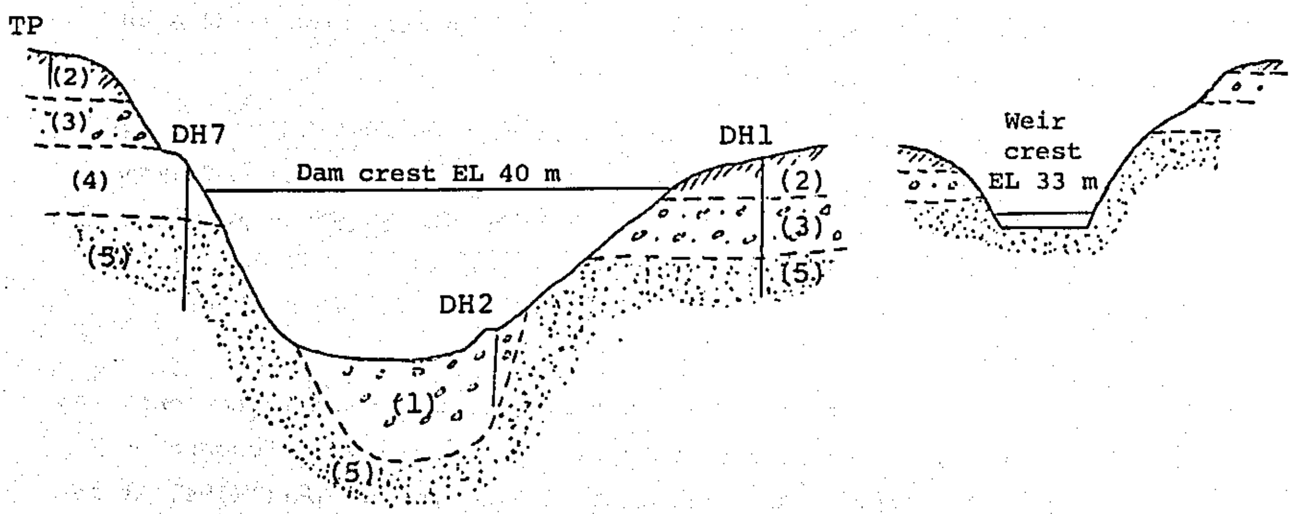
K. Uno
Aug. 28, 1979

Comment

It is difficult to think that the data in the report is perfectly readied for design. But how and when the supplemental survey to be done is deeply concerned with the external circumstances, and then the construction schedule. Therefore, here, the data already got in the report and further necessary items for basis and materials of closing d dam in general planning are written for reference.

(1-1) The sketch profile to get the general idea of dam geology.

On the next figure, the reduced scale varies arbittarilly.



The explanation of above geological layers

(1) Gravelly layer (River bed deposit)
(2) Upper soil layer } (Terrace deposit)

(3) Lower gravel bearing layer
(4) Clay stone layer
(5) Sand stone layer (Tertiary deposit)

DH: boring TP: test pit

The boundary of each layer are estimated ones except boring positions.

(1-2) About the basis

(1) Gravelly layer of river bed deposit

Consitution is estimated to be gravels and sands mainly. Boring DH2 (10 m) did not reach the base rock i.e. sand stone (5). Thickness and distribution of this layer is not known. As this layer is supposed to pervious layer, and no data in the report, the problem of treatment will be posed.

(2),(3) Terrace deposits

They distribute on left and right side both. As the elevations of deposits are different, they are supposed to be formed at different geological ages. Soil layer((2) on the left side is thought to be used as fill materials.

Terrace deposit (2)(3) on the right side must to be the dam basis. There are no data about their bearing capacity and permeability. If the gravel (boulder) bearing layer (3) is permeable, it will raise a problem of foundation treatment.

(4) Clay stone layer

As a comperatively older deposit (Tertiary sedimentation), the clay is fairly compressed and shows N-Value = 9 (by standard penetration test). As consisting of fine grained particles, it is supposed to be impervious.

(5) Sand stone layer

As consisting of course grained particle and compressed, it shows N-value of more than 60. Judging from its compacted condition or dewatering under excavation of weir site, coefficient of permeability is estimated to be more than 10^{-4} cm/sec at least.

(1-3) About the fill materials

The borrow area is now assigned on the hill top of left side i.e. soil layer (2). As the report said that the volume of materials was too small compared with the reaquired volume, the reexamination collating to geological condition is now going on. About the deficiency of volume, it is worthy of studying the properties of gravel bearing layer (3) and clay stone layer (4) on the left side as fill.

About the design values of the fill materials get from soil layer (2), e.g. friction angle (Ø), cohesion (C), unit weight (γ) or moisture content ratio, the way to deduce the parameters must be explained in the text.

(1-4) About the alternative dam

It is worth examining the new alternative plan of dam on the upper stream of present site to reduce the dam volume.

"2" Advice

This paragraph is not a concrete advice for each items in the report. But, from the impression after reading, this advice suggests the line of thinking to write the report and then suggests how to deal with the various surveys in planning stage.

(2-1) Whole figure of project

The outline of whole project and preliminary dimensions of structures must be written at the head of report. Thus we can understand the purpose of each survey. Being based on it we can consider the method of survey to be adopted. Sometimes, it might introduce the new alternative idea of the different sorts of surveys e.g. for selection of structure site, borrow area or channel route etc.

The items of survey are usually almost presented, but of ten they are not arranged synthetically. Coherency of planning must be a motive to form the report. The lack of such unity is responsible to both the order side and contractor side through no sense of whole picture of project.

(2-2) Coherency of surveys

The above mentioned idea are required to each field and laboratory investigator too. The effective method to be adopted in each survey must be examined basing on the understanding of whole planning. And also it must be based on field observation of natural circumstances. It is not too much to say that each investigator can't get practical idea of survey plan until he stands on the field. At that time, designer, geologist and soil mechanic engineer will find the duty to ask each other, and then the priority or balance of surveys namely the cooperation of investigators will be realized.

These matters are the same to a foreman of boring and a experimenter of soil mechanics. He should not be a mere executer received order. He must understand the purpose of his work for design. He must select the method effective to the field condition and examine the value he get. In order that, he must always try to get new information and have intension to improve the method. As engineering geology and soil mechanics are comparatively young technology, so they have the practical limit and chance of improvement widely.

(2-3) Text and appendix

In one report, the naming of layer, materials, prefix of test etc. must be kept in consistency. In case that it is necessary to use different name or sign for the same object from the view of different idea, their relation must be explained clearly in the text.

For a reader to study the report, each explanation in text must be followed by page number or appendix, table and figure number to be referred. If not, it will easte much time to look for the basic data to be assessed.

(2-4) Geomorphology

Geographic maps which used to study, must not be restricted to the construction site but also be extended to examine the alternative plan. Sometimes we need to know the beneficial area too.

About morphological feature nearby structure (in case of weir), it need to give special attention to the following phenomena.

Feature of present river bed, relic or old river bed flood plain, terrace, cliff, talus surface slope, sliding sand and gravel deposit, symptom of river bed movement recorded flood trace etc.,

As these phenomena are often related to geological condition, morphological feature is desirable to display on geological map, as far as possible.

(2-5) Geology

1) The extent of field observation must not be limited within the map range attached in the report. It must be enlarged as far as the geological feature of construction site can be grasped. On the other hand, the description of regional geology must be only given to support the judgement that the geological interpretation about foundation and materials has the appropriateness in wide field vision. It must not only be an ornament in the report.

2) In geological explanation in text, the synthetic results of soil mechanic study must be included. The quantitative elements of geological feature will become more clear e.g. for property of sediment at borrow area, estimation of the stability of cutting and depth to be excavation etc. It is the same as rock mechanic, geophysical or petrological survey. The results of petrological study must be described concenring to the classification, geological are and relation to engineering property in text.

3) *Boring* method is apt to consider the most important method. It is true but their information are usually limited. Surface survey is also important, for instance, the boundary of layer in geological plane and profile must be decided precisely by trench. In case the principal engineering elements like strength, permeability, grain size distribution etc. can't get from boring method, we must try to get them from surface method as trench, adit or test pit. These arrangement of method are responsible to geologist.

Several methods to be operated in the field must always be taken care of their test condition. If the controle of test to fit for each condition fails, the result will cause big error.

4) About the nature of borrow area, soil kind, distribution, quantity can't discussed without geological consideration. The determination of quality and quantity of borrow pit places joint responsibility on geologist and soil mechanic engineer. The rough estimation of required volume of materials must be given before survey.

5) About the construction materials (rock gravel, sand, soil), its location, approximate volume, natural condition, access road, hauling distance etc. must be reported.

6) The discription or consideration about groundwater is worthy as symptom to throw light upon geological structure. The subject of engineering geology are consisted of water, soil and rock.

(2-6) Soil mechanic test

1) The purpose of test must be written in the report. The method of sampling and test should be different on each purpose. About the supplementary test, meaning of test or relation to other data must be written e.g. qc and N-Value, uniaxial, direct and triaxial test.

2) The discription of how to decide the design parameter from many tests, gives the conclusion of tests and is one of the main item of report.

3) The summary list of tests must be arranged to be able to understand easily the above mentioned procedure.

(2-7) The others

1) Core sample and tested smaple msut be kept in field office. Each field staff can get the knowledge about the engineering property of foundation and materials by collating with the report and have the idea for construction.

2) Record of construction is said necessary to give the new experience to civil engineer. Not only that, but it is useful even under the construction. Following the progress of operation, the contents of the report must be confirmed or checked again. The modified idea possibly directs new operation. So it is desirable to study the newly appeared condition by expert at the appropriate stage of construction.

"3" Questionnaire about the content

Volume I (geology)

Page (1) Period of survey March 13 till? 5. There many other empty spaces.

(2) Detailes of falling and constant head method? (relating to page 36)

(3) Could you use topographic map of 1:5,000 during survey?

(11) Explanation of frequency 1 x, acceleration (seimsic intensity?), Richter scale (magnitude)?

(12) Flood level, + 2 m. Does it derived from flood plain, flood mark or hearing?

(13) Explanation of relation between heavy rain and cutting away of vegitation (I dont know well such phenomenon), between terrace erosion and ground water.

Explanation of meander phenomenon at south of bridge.

(14) Detail of river system pattern. Its necessary to consider the general planning or its alternative.

(15) Explanation the conclusion that this area is faulted. The meaning that clayey sand stone is porous?

(16) Which is better to name clay or shale? The evidence that lateral distribution is not extensive and deposited comformely. The continuation of west central and east terrace? Top soil is included in terrace deposit or not?

(20) No description of faults (referring to page 15). This strike different from one on page 38.

(21) N-value. Permeability (K). Results of soil mechanic test are more important as physical property for civil engineering.

(23) Excavated material is 5 - 7 m? There is no description on section of DH 1. River deposit thickness varies 8 - 10 m, no description on DH 2. Borings must be forced to do in the river.

(25) Thickness of calcareous sandstone is 5 cm. Misprint?

(26) Why did you test permeability only for sand stone? Clay's K is 10^{-2} cm/sec on section of DH 7 ?

(27) Clay is medium consistency? Generally N = 10 is stiff and N = 69 is hard (DH 7).

(28) Are there any definition of pseudo coherent (sand stone) semi coherent (terrace deposit) incoherent (in water)? The location of sliding at east side of river? Avalanch steady accured on terrace deposit or not?

(29) The location of spring? (relating to Fig. 2)

(30) Pressured ground water, its head or flowout volume and pervious layer? Reservoir problem, if permeability if 10^{-2} - 10^{-3} cm/sec, almost can't available as to reservoir.

(31) A good bearing capacity must be explained by quantitatively.

(32) The foundation of closing dam includes clay layer and terrace deposit. Did you understand that?

(34) Can you study the borrow pit without the knowledge of required fill volume? Why did you choose this area as borrow? The name of soil is better to show by unified soil

is better to show by unified soil classification, they are precise and easily related to construction material of foundation.

(36) The location of borrow must be written correlating to geology and topography. Excepting it, how to decide the reserve of available soil? The location of other materials (sand = flood plain, rock = river deposit) must be shown in map. Without the estimated reserve volume (thickness and extension etc.), they can't be available for planning.

(40) From this page to the end, there are descriptions about micro scopic study. What was the purpose of micro scopic study and why don't you summarize the results. The study must not be the selfsatisfaction of geologist. How to measure the porosity? It seems too small, better to compare with soil mechanic result.

Figure (1) If the outer form of structures are not drawn on geological map, it's not easy to know the relation for engineering work. Why did'nt you write the borrow area?

(2) The upper part of DH 1 is made as top soil (on columner section, it's clay). The ground water level is differ from the columner section.

(3) Could'nt find any large faults by correlating the bothside out crops of weir excavation? May we consider to horizontal the boundary between sand stone and terrace deposit in central terrace? And how about boundary between clay and sand stone? They are important to consider the faults in this area.

(4) Diagram. Indicate clay and terrace deposit on west side. Where and how is the joint between central and west terrace?

(5) Diagram. Is the location of DH 1 correct? What is the difference of top soil?

(6) Columner section DH 1. We want the soil mechanic data and permeability of clay and rock fragment. The name of soil or

rock must be standardized.

DH 2. Did'nt reach to the sand stone? Permeability and grain size distribution are necessary.

DH 3. DH 4. Permeability of calcareous sand stone?
DH 5. DH 6. Description of pressured ground water. The purpose of these boring (depth El - 25.80 m)

DH 7. Calcareous sand stone was not sampled (relating page 51) the reason of difference of core recovery of clay layer?

Generally speaking, why there are not description of circulation water loss?

Ground water level is always different by 20 cm or so in every morning and afternoon?

Volume II Soil echanics

Page (1) Which items are done under natural condition? (e.g. γn under disturbed sample)

(2) Please explain about the modification of A.S.T.M. suitable for the Indonesian soil.

(7) How to get modulus of elasticity (Es) from consolidation test and where is its result?

(9) ø.c of foundation (DH) are not written in summary. Sensitivity test is rather necessary for fill material.

(10) C, C_1 and C_2 are tested on remoulded sample? Is it meant that sand stone might be used as fill material?

Is there no relation between these K and permeability in boring?

The relation between sandy silt (from soil mechanic test) and clayer sand stone (from rock description)? Calcareous organic material should be treated as O in unified classification or not?

(11) Thickness of ±20 m can used for fill mateiral or not?

(12) Pit numbers are lack on the geologic map.

(13) Don't you thick Ø are too large for silt?

(14) How to decide the Ø, C, γn as design value must be written. It becomes conclusion of soil mechanic tests.

(15) Why do you choose 7 as weighted creep ratio (7 fine sand in the table)

(16) Meaning of C_1, C_2? The difference of equations in case we used Cc and Cr?

(17) Why is there such difference between dam foundation and levee foundation (relating to page 19)? How to explain the difference of permeability of 10^{-6} to boring permeability of 10^{-2}?

(18) Difference of design parameters between this slope stability and slope calculation (weir, page 19)?

(20) C = 1.30 kg/cm^2 is miss print?

Figure (1) Grain size, soil classification is better to use unified soil classification than triangular coordinate. It is directly related to foundation and fill material. But it needs to add the sieving of 74 mm.

(2) Atterberg test, the purpose of test? Isn't the purpose for soil classification?

(3) Consolidation, please explain the method to calculate C_1, C_2.

(4) Direct share, difference between Ø m Cm, Ø n Cn?

(5) Unconfined compression, how to use qu?

(6) Compaction, definition of γd and γdry? γwet is the same to γn?

It seems too narrow the test range of γd (for water content).

(7) Sensitivity, what can we learn from this test?

(8) Triaxial compression, why are there some tests without calculation of Ø', C'.

Table summary list, the locations of some test pit can not find in the map. Is there some standard about the description of soil? Difference between sand stone and clay? All the results of tests are not summarized in this table. Especially, the most important parameters such as Ø, C, γd must be written with their test method.

COMMENT ON THE SOIL MECHANIC, GEOLOGICAL REPORT
OF CILIMAN WEIR, TELUK LADA PROJECT, WEST JAWA.
(WIRATMAN & ASSOCIATION, JUNE 1979)

K. Uno
June 29, 1979

(1) About the text

1. The results of the soil mechanic study must be arranged in view of geological stand. Each characters of rock type may be cleary expressed by symbol of soil classification. Character of layers may be easily grasped by the rough ratio between fine and coarse grain rock in each layer. Hand boring and corn penetro were done together at some point, so rough correlation between rock name and qc must be written for other penetro test. (P14)

2. Erosion surface (unconformity) was cleary drawn in columner section, so it need some explanation on the observation of out crops and borings.

3. Firm surface was defined. If there are some relation or hypothetic relation with erosional surface or topographic feature, please write them.

4. More detailed description is better about the distribution and characters of grand water (including artesian water) because it will be needed for dewatering, selection of borrow area etc.

5. There is a result of calculation on slope stability. It needs to write the propriety of failure factor (Ø.C etc.) used on calculation in case of such kind of report. (P17).

6. In such sandy foundation, piping phenomenon is apt to occur. As the boring data at weir site show that the bed rock is $N > 60$, $K = 10^{-6}$ cm/sec, there may be no problem. But river bed as the foundation of dyke show that, DH 7 is ($N = 25$, $K = 10^{-3}$, PI 15-24, SP-CL) and DH 8 ($N = 13$, $K = 10^{-2}$, PI -, SP) by the depth of

4 - 5 m. Such point must be pointed out for design.

7. Was not the study of borrow required in this report?

8. It is desirable to write the reason why this site was selected and the other alternatives were rejected.

(2) About the method of survey

1. To know the characters of soil as foundation, undistrubed sample are necessary. On such site, the trench may be useful for sampling and observation of geological feature.

2. In drilling columner section, what is the meaning of before and after in item of ground water? Which is considered to real G.W.L.? Please explain progress, existing material, missing of % loss.

3. Couldn't get undisturbed samples even in case of N > 60, what kind of method the dry boring is?

4. Why DH10.DH11 are added? In this case, could get undisturb samples or not?

5. Please teach me, the scaffoldings of DH7.DH8 in water.

6. The depth of hand boring are 8 - 10 m and sugar can penetrate by the hardness of qc = 50 kg/cm^2 or so. Undisturb sample can get easily? Teach me.

7. About disturbed sample (D.H. sample), such test items are necessary or not? (Att. 13)

8. It must be shown cleary whether natural condition sample (as foundation) or consolidated state sample (as material). (Att. 14)

9. Please teach us the analysis method of compression figure (Att. 18-22)

(3) About the attached figure

1. The legend is not enough (e.g. DH. S etc.). The out ward form of structure must be laid out in each plan and section. It's better to write Ground water level and permeability coefficient in section. (Att. 1-9)

2. It is easily understandable if the soil type of sample is put in the description. The elevation of H.B. is missing. (Att. 10-11)

3. Discrimination whether natural sample or not must be shown. (Att. 13-14)

A SUGGESTION AFTER READING THE GEOLOGIC AND SOIL MECHANIC FINAL REPORT OF BATANG ULEH DYKE (C.V. ISUDA, DEC. 1978.)

K. Uno.
Feb. 1, 1979

1. About the permeability

Though the calculation of seepage is needed to estimate the dewatering, its rough estimation is possible from the data of excavation of weir foundation.

In this case, coefficient of permeability (K) is necessary to design the blanket as a countermeasure for piping. For this purpose, total K of pervious layer is required. It is not adequate to know the partial layer's K only (besides, the values of K got from tests are unthinkable when they are correlated to grain size distribution described in boring section).

At present stage, proposed length of blanket may be acceptable, assuming that the pervious layers are something like gravel bearing sand or sand bearing gravel.

In the report, the adoptation of grouting was recommended but blanketing may be easier than grouting.

Advice 1. From the core of boring, it is usually difficult to know the condition of river deposit to consist of coarse grain particle. Thin wall sampler is only adoptable for weak clay. As K may sometimes be reflection of character of sand and gravel layer, it is to be desirable to make efforts to get K from reliable test.

Advice 2. The confirmation of depth of granite gase (impervious boundary) is not always easy. because it often fails to take a huge boulder for a base rock.

Advice 3. As there are some general forms as civil engineering data, the style of description of boring columner section should be follow them.

2. About the dam body material

The soil samples taken for soil mechanic tests may be approval as the material of dam body, however, their sampling positions are always at the depth of 3 m from ground surface.

The hillside slope was formed being subjected to the influence of weathering from granite. Therefore the weathering degree (soil composition) is altered considerably and soil becomes coarser and coarser according as th depth increase. Such status is clearly shown in Boring III.

Then, excavation plan and quality control must be considered previously to get homogeneous material.

Advice 1. Necessity to confirm the compaction effect by filling (rolling) test at first hand.

Advice 2. Necessity to take care of optimum moisture content as it is very low. (there is no description about site moisture content).

Advice 3. About the soil classification in the report, it is better to use Unified soil classification rather than Casagrande's classification.

3. About the blanket material

The borrow pit for blanket material is now assigned to the excavation waste of upstream of weir (riverdeposit), but its quality is not assured yet and supposed not to be satisfactory. The examination is required. Besides, there is no way to haul the material under the present progressive schedule.

4. About the slope protection

As the dam material is rather coarse, so the qully erosion (hollow water coruse) is apt to occur by rain on the slope surface. Gabionade or riprapping is scheduled for upstream slope but some protection (drainage and sodding etc.) is necessary as soon as possible after filling for down stream slope too.

EXTRACT FROM "REPORT ON DISCUSSION AND FIELD SURVEY FOR BATANG ULEH CLOSING DYKE IN JAMBI PROVINCE, DEC. 1978"

The following personels participated in our field survey and made a discussion with us at the job-site on November 28th.

Mr. Bistok,	Sub-chief of Water Resources, DPUP Jambi.
Ir. Inshan D.S,	Construction Service II, DITGASI.
Mr. Sukandar,	Director of C.V. ISUDA.
Mr. Sarjuno,	Chief Designer, C.V. ISUDA.
Mr. Wang Suwandi,	C.VA.A. Bun Sendi.

3. Summary of discussion and technical comments on Batang Uleh Closing Dike

3.1 General

The project is located in the western part of Jambi Province, on the border of South Sumatera Province. (See Fig. 1).

Irrigation area consists of 1,571 ha (Q = 1 646 cu. m/sec) in the right side and 250 ha (Q = 0.298 cu. m/sec) in left side totaling to approximate 1,800 ha.

A diversion weir has being constructed by Coupere Method since April 1978 on the Batang Uleh which is one of the tributaries of Batang Hari.

As of the end of November 1978, main crest, downstream apron and most part of retaining walls in the both sides have been completed.

Construction at present concentrates to bridge, remaining part of walls and backfill behind the right side retaining wall.

The diversion weir and its related masonry works will be completed before long.

A closing dike on the roginal river shall be constructed so as to switch the riverflow to the excavated diversion canal and the intake facilities.

C.V. ISUDA, a consulting engineer Bandung, has prepared the Report but design is still preliminary stage.

C.V. ISUDA has also undertaken the geological survey and soil mechanical investigation, studies of which will be soon finished.

The general layout of Batang Uleh diversion facility is shown in Figs. 1 and 2.

3.2 Geology at closing dike site

(1) The diversion facility for Batang Uleh irrigation project is located on the Batang Uleh about 6 km upstream from the confluence of the Batang Tebo.

The project site is embraced by hill zone which is in approximate EL 100 - EL 150 m.

The geology of foundation in thepproject site is supposedly consisted from granit intruded in Jura Era, which differs from the geological maps prepared in 1919 and in 1975.

In the downstream area in where main canals will be contemplated, there are found tertiary hills.

(2) The granit foundation in the project site is fairly weathered as shown at the excavated place in the south of weir. The boring test conducted on the north hill side at EL 89.73 m, shows the following geological stratum.

Ground surface - 6.70 m	Silty or sandy clay
6.70 m - 16.0 m	Silty sand
16.0 m - 21.5 m	Weathered gravel layer
Deaper than 21.5 m	Fresh granit

Thus, the upper part which is of clay will be main material of embankment. The lower it becomes to, the more sandy becomes the material.

(3) The deposit placed in the river-bed was confirmed by two (2) borings made at the abutment of closing dike on flood terrace (El 71.6 m and-EL 72.0 m), results of which are as follows.

	Top soil	Humus layer
	Top soil - 2.5 m	Silty fine sand
or	Top soil - 2.9 m	Sandy or silty clay
	2.5/2.9 - 10.25 m	Sand layer including gravel
	at 10.25 m or 10.50	Fresh granit

(4) Dutch cone penetro tests in the river bed revealed that bearing capacity at 1 - 2 m in depth was more than 200 kg/cm^2, showing that the layer consists of sand and gravel one. The boundary of stratum has been obviously confirmed by electric exploration made in 1972.

Generally speaking, it is difficult to collect samples from those unconsolidated deposits.

Only way to confirm the foundation geology thereof is to observe the excavated place of weir from the geological views.

(5) With regard to ground water table, it is almost same at the river water level at the bottom of valley and becomes a little bit higher toward hill side.

(6) Permeability coefficient was estimated by recovery method to be $1.7 - 6.4 \times 10^{-3}$ cm/sec for the layer from 4.4 m to 5.7 m.

According to the bearing investigation at the field survey, there was found about 100 lit/sec of pumped up water on the occasion of excavating the weir foundation. The fact could suggest us that permeability coefficient would be $10^{-1} - 10^{-3}$ cm/sec.

3.3 Embankment material

The volume required for embankment was estimated approximate 60 thousand cu.m based on the draft design in the Report.

Since the proposed design will be midified to decrease the crest width and to additionally install a blanket in the immediate upstream of dike, embankment volume will accordingly change.

In general, quantity of required material in borrow areas will be two or sometimes three times as much as embankment volume. Available volume from the proposed borrow areas on the left and right sides is regarded to be enough in quantity according to the ISUDA investigation.

The field survey revealed that excavated materials from the diversion canal of the upstream and the downstream are judged to be not suitable for embanking because these are almost sand including gravels. For our reference, the following figures, which will be late on revised, are used at the draft design stage.

Optimum water content	W_{opt}	= 21 %
Max. dry density	r_d	= 1.6 ton/cu.m
Internal friction angle	Q	= 17°
Cohesion	C	= 2 ton/sq.m
Permeability	k	= 10^{-6} cm/sec.

On the other hand, materials in the borrow areas on both sides are of weathered granite and belongs to CL as a whole. For reference soil mechanical characteristics described in ISUDA report are as follows.

r_n	= 1.93	Q	= 34.6°
r_d	= 1.6	C	= 0.16 kg/sq.cm.
W_{opt}	= 21 %	WL	= 52 %
W_n	= 25 %	IP	= 32

The materials of the borrow areas are judged to be available for embankment.

3.4 Seepage and creep length

As stated in the previous section, the foundation geology is consisted of permeable layer and an estimated permeability coefficient is 10^{-3} cm/sec.

Seepage quantity through the said permeable layer was estimated 3.2 lit/sec per 110 m.

In case of Tougo regulation dam Japan, which has a 150 m long and 1.7 m thick (max) blanket in the upstream side seepage quantity was estimated 8.9 cu. m/m day (app. 10 lit/sec per 100 m) through 9 m deep pervious foundation. Seepage quantity of 3.2 lit/sec is not seemed so serious problem.

However, it is necessary to check hydraulic gradient or creep length against piping action, for example, by the way advocated by Bligh as follows.

Critical Creep Ratio

	C_c	C_w
Fine sand	15	7
Coarse sand	12	5
Mixture of sand & gravel	9	-
Coarse gravel incl. cobble	4 - 6	3

Where: $C_c = \frac{L_c}{h}$, $C_w = \frac{L_w}{h}$

L_c = (horizontal creep length) + (vertical creep length)

$L_w = \frac{1}{3}$ (horizontal creep length) + (vertical creep length)

h = hydraulic head

In case of C_c and C_w based on the preliminary design in the Report, those are calculated as follows, which are insufficient for the assumed critical creep ratios of 10 for C_c and 5 for C_w.

$$\bar{C}_c = \frac{L_c}{h} = \frac{1}{12.4} (92 + 8) = 8 < C_c$$

$$\bar{C}_w = \frac{L_w}{h} = \frac{1}{12.4} (\frac{92}{3} + 8) = 3 < C_w$$

In order to increase creep length and in order to be satisfactory against the critical creep ratio, cut-off work or blanket work are conceivable. As a result of discussion, installation of blanket was judged to be reasonable for Batang Uleh Project in addition to shallow cut-off work which does not reach to the impervious layer.

3.5 Design of Blanket

A theoretical solution given by BENNET and a practical formula are shown in Fig. 3-(1) and (3)-(2).

Blanket length is in general several times as long as water depth.

The length of blanket and seepage quantity for Batang Uleh closing dike are derived as follows based on a practical formula.

Length of blanket $x_E = 50$ m

Seepage quantity $q = 0.7$ lit/sec per 100 m

C_C and C_W after a 50 m long blanket is 12 and 4.5 respectively, both of which can nearly be satisfactory for the critical value.

Seepage quantity is also decreased to approximately 20% of the original estimation (3.2 lit/sec per 100 m).

With regard to thickness of blanket, it is generally about 1/10 of water pressure or 1 - 3 m.

The contact part to dam embankment is preferably thicker than other parts and then it gradually decreases toward the upstream.

Material blanket is almost as same as impervious one for embankment.

At the discussion, it is reported that the upstream of diversion weir is covered by deposit clay, which is deemed a natural impermeable blanket.

3.6 Design of closing dike

The design of closing dike proposed in the Report is still in a preliminary study stage. For further study, we discussed on and agreed to study on the following major items.

1) To install a berm ($b \doteq 3$ m) on the upstream slope

2) To decrease the crest width in accordance with the width (3.5 m) of bridge

3) To install rip-rap or gabion for protecting the upstream slope

4) To place a horizontal drain and toe drain in the downstream side

5) To use filter materials in the transition parts between pervious and impervious ones

6) To review stability analysis after soil characteristics are confirmed by soil mechanic tests.

In this case slope is 1 : 3 for the upstream and 1 : 2.5 for the downstream respectively.

7) To install a blanket in the immediate upstream of closing dike as well as a shallow cut-off proposed in the Report.

8) To prepare a geological cross section at the closing dike site.

9) To use flexible and non-seepage materials for the conducting canal on the downstream slope.

For example, pudel, reinforced concrete flume, and concrete or metal pipes etc.

Based upon studies or discussion stated in the previous sections, a basic design of embankment, ie., standard cross section and plan of the closing dike is proposed in Fig. 4.

Total embankment volume is tentatively estimated approximate 50 thousand cu. m including blanket based upon Fig. 4, the plan of which is too small to precisely estimate volume required for the closing dike.

3.7 Settlement of embankment

The settlement of embankment itself was estimated about 23.9 cm based on the analytical way in the Report.

Actual settlement of several ten dams recorded in USA is shown in Fig. 5, which shows settlement ratio depends on dam type or compacting condition and it is more or less 1 % of dam height.

Tougō dam and Saburi dam in Japan shows the settlement ratio against dam height is 3.1 % and 4.8 % respectively.

Consequently, the camber of 50 cm, in the Report, which will meet 4 or 5 % of dam height, is judged to be reasonable.

3.8 Soil bearing capacity

According to the probe test (Dutch one ?), the bearing capacity of fine sandy gravel layer is more or less 200 kg/sq. cm. It is strong enough for the increased stress due to embankment, which is derived by Asterberg's Theory as shown is the Report.

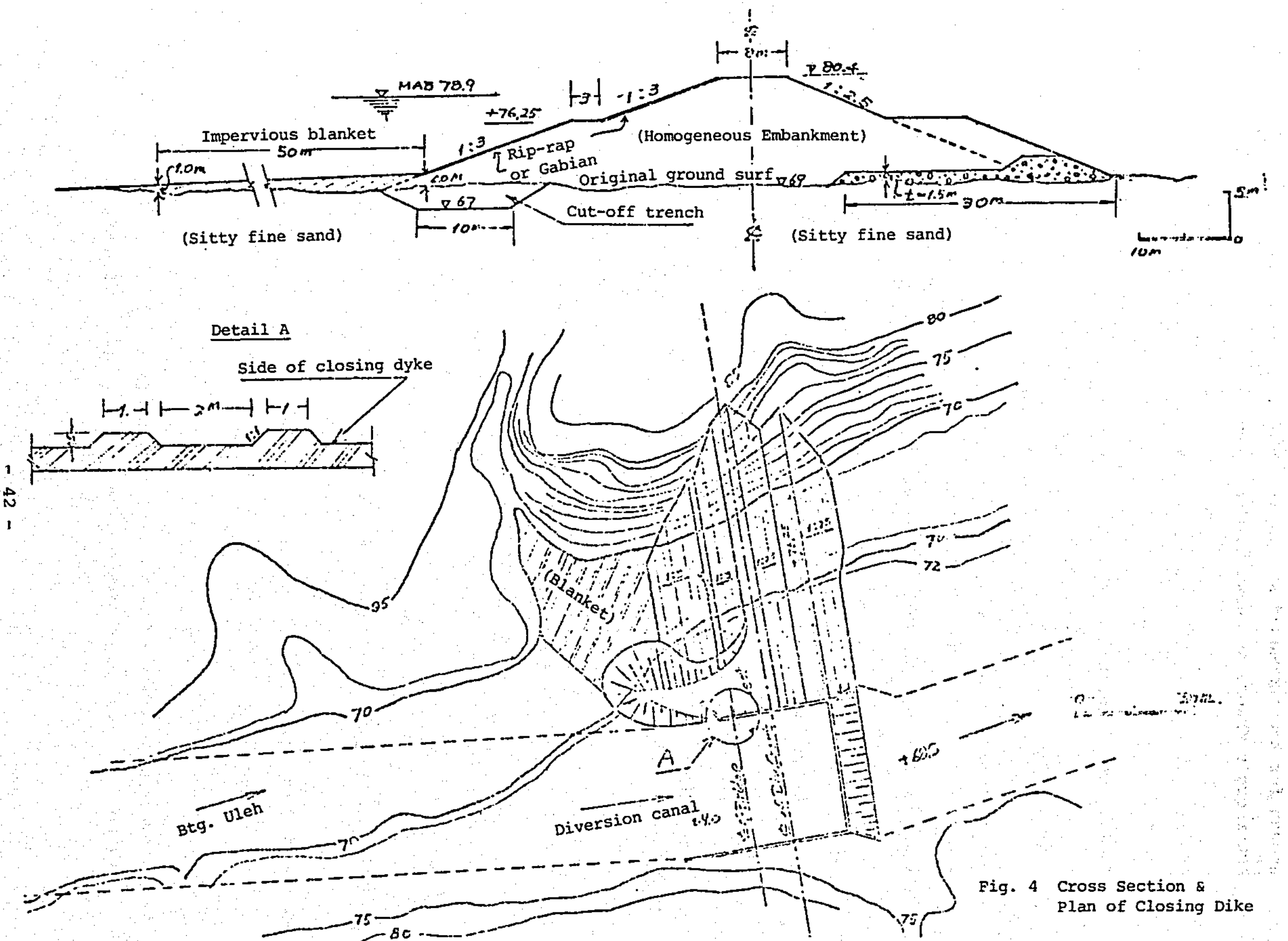


Fig. 4 Cross Section & Plan of Closing Dike

HOW TO WRITE A GEOLOGICAL AND SOIL MECHANIC'S REPORT

Nov. 18, 1978

K. Uno

- Using the report of Batang Uleh as a material for discussion

A. About the appended figures

Fig. 1 The location of construction site is not indicated precisely. Fig. 1 is required to connect to Fig. 3.

Fig. 2 Legend (explanatory notes) is not shown. A part of T.P., S.U. are not seen, the E.L. (meters above sea level) of each test point must be able to read. Why are there difference between Fig. 2 and Fig. 4 about topography and river direction.

Fig. 3 This figure should be next to Fig. 1. What is the meaning of Plateau sub Barison.

Fig. 4 This figure should be next to Fig. 3, this must be an out crop map and shown the morphological features (terrace, old river bed etc.) and weathering condition. As the height of river cliff is 3 - 4 m, the details of geological profile must be described, if possible. Outlines of weir, coupur, channel and access road etc. are required.

Fig. 5 The location of site is not shown. Please explain me the way of looking at.

Fig. 6 The way of description is better to consider again.

Fig. 7 The E.L., ground water level and sampling position are not written. The relation of present river deposit and geological meaning of humus or coral must be explained in the text.

Fig. 8 This one should be next to Fig. 2. It is desirable to use the 1 : 500 or 1,000 scale's map together with Fig. 2 and draw the outlines of weir, dyke and excavation line, if possible. It is also better to take the same scale on vertical and horizontal direction.

Fig. 9 Lack of E.L., groundwater level and sampling position.

Fig. 10 The way of discription

Fig. 11 There is the CC (compression index) used for ?

Fig. 12 Why were the 50μ and the 5μ adopted as the standard of grain size classification ? (see text Page 17)

Fig. 13 If then is porosity, it should be expressed by %.

Fig. 17 Should be next to Fig. 8, classify following dam geology and construction material, soil symbol.

B. About the text

Page 3 Needless description about the Permo-Carbon stratigraphy

P. 4 Explanation of acceleration and probability of earthquake

P. 5 Needless description about tertiary

P. 7 Difference between site geology and dam geology
Classification of dam geology - flood deposit, loose fine sand and river bed deposit (by 4.8 m in depth)

P. 8 Permeability test indication of E.L., desirable to measure at each rock facies

P. 9 Indication of groundwater level by E.L., necessary for dewatering with permeability, fluctuation between dry and wet season, relation to river water level

P. 9 Construction material, thickness, area, proved reserve, grain size, occurence, location, topography, hauling distance and condition.

P. 10 Constituent rocks must be connected to classification of dam geology

P. 13 List of penetration test, only show the depth of test, it's meanless if the resistant values are not correlate to classification of dam geology

P. 14 Test pit of 7m, the geological meaning of humus and coral bearing layers and their relation to river bed deposit

P. 16 Meaning of Es, ϕm and ϕu

Page 17 List of soil test, no meaning of average value without geological classification

P. 23 3 zones structure, usually compaction of 90 % is in allowable range

Boring columner section: Follow to standard specification, fresh granit may be picked up as cylinder shape core.

Source: Please explain the source of next items. Drawdawn stability chart of Morgenstein method (P. 20), use the øc of 60% in case of direct share test (Design P. 5), calculation of soil stress (Design table 3) and settlement (Design table 4).

EXTRACT FROM "DESIGN OF TLOGO DAM" (INTERIM REPORT) SEP. 1978

Geological feature and nature of soil

1. Regarding to the reports of subject above mentioned, there are Technical investigation report (1975) and Laporan penyelidikan geologi teknik and mekanika tanah (1976). But Laporan penyelidikan geologi teknik (1978) is not yet completed, therefore this paragraph is only briefed for readers of this interim report as their background knowledge.

2. Topographic condition

   The damsite is situated in the hilly district, about 20 km south of Rembang, Central Jawa, which is geologically called to North Rembang anticlinorium area. Including the catchment area, the height of reservoir is between 100 and 300 m above the sea level. And the basin expected to be reservoir is narrow and stretched to EW direction and it lies between the ridges of 2 lines, which have relative height of 100 - 200 m.

   The basin is composed of relativelly soft rocks like shale and sand stone, and the ridges are consisted of relatively hard rocks like calcarious rocks. The destribution of rocks is reflected on the topography of this area.

   Kali Gude run from east and Kali Tlogo run from west join Kali Besek, which flows northwards through the northern ridges. The valley shows narrow and steep slope of 300 gradient.

   The proposed damsites are situated on the entry to the valley (= alternative I) and on downstream about 100 m from the former (= alternative II).

3. Geological condition

   The geological components of this area are sedimentary rocks such as skale, sand stone, calcareous rocks (karren limestone, kalkarenit calcareous sand stone) which were sedimented during miocene (about 10 million years ago) and the area is widely covered with mantle deposits such as weathered rocks or river deposits.

The strata generally shows the strike of EW and the dip of 25 - 35°.

At the alternative I site, the mantle deposit such as elayey sand, sandy silt etc. is developed by 3 - 5 m in depth and base rock is loose sand stone.

Therefore, the volume of excavation will be larger and the bearing capacity of foundation has to be examined strictly. The required dam volume is perhaps larger than the alternative II. Besides, according to the plan of alternative I, the excavation for spillway is required about 8 m in depth.

At the alternative II site, weathered rocks or river deposit is rather thin. The constituent rocks are kalkarenit, calcareous sand stone. A fault across the dam axis is estimated but the details are now investigating.

The layers incline to downstream. The N-value by standard penetration test are, mostly more than 50 for sand stone bearing shale and sometime 18 - 30; mostly more than 50 for calcareous sand stone or kalkarenit. The coefficient of permeability are, mostly 10^{-4} - 10^{-7} cm/sec for sand stone alternating shale, 10^{-4} - 10^{-6} cm/sec for calcareous and stone; almost 10^{-4} cm/sec for kalkarenit and partly 10^{-2} cm/sec.

4. Construction material

The banking samples taken from hillsides near damsite are high plasticity inorganic clay and CII according to unified soil classification.

Though maximum drydensity is thought to be 1.5 t/m^3 and optimum water content ratio to be 23%, it doesn't to suit as dam material. From these data of soil mechanic test, the result of stability analysis for homogeneous earth dam suggests the section which has the upperstream slope of 1 : 3 and the downstream slope of 1 : 2.5

As for the quality and quantity, the survey of this soil, coarse-grain material or rock material is not completed yet.

5. Reservoir basin

In this basin, we can find four springs and the villager use them as their domestic water. These springs all occur in calcarious rocks and are situated above the height of 120 m except one. It means the leakage through the reservoir wall might be negligible (in this connection, the hight water level of reservoir is lamost 120 m). Though it is considered the base rocks and their mantle deposits act as natural blanket near the damsite, further examination will be required.

Several land slides are found in the basin and they apt to occur on the soft alternation of shale and sand stone inclined to north. They are required to consider regarding to the accumulation of sediment in reservoir.

Suggestion for geologic-soil mechanic survey hereafter

1) Geological problem for dam site

a. 1st alternative site

a-1 According to the result of seismic exploration, the existence of fault (provably to form leakage route) is estimated at the left side a little apart from planning dam body.

So its necessary to check the feature of this fault. It might be connected to the leakage between 20 - 25 m depth in Boring No. 3

a-2 Is it possible to know the reason why N - values in Boring No. 6 are low (N = 18 - 30) compared with other borings on same dam axis

b. 2nd alternative site

b-1 The fault of left bank, estimated by seismic exploration, seems to be assured in Boring No. 10. But its detailed scope is not clear yet.

b-2 Another estimated fault crossing the dam axis obliquely, was not examined yet, despite suggestions on report of '76 and '78. To consider the treatment, the fault must be made clear by detailed outcrop survey and borings.

c. Comparison between 1st and 2nd alternative site has to be judged on the better condition for execution (e.g. dam volume, foundation treatment etc.)

2) Construction material

a. For fill materials, soils on hill in reservoir area were tested. Though the maximum dry density of soils is expected to be 1.5, soils are under CH group by unified soil classification. Generally speaking, they are hight plastic clay, impervious, rather low as to stearing strength, considerably difficult to execution and concrete case example are few.

b. It is said that quartz sand stones distribute widly in the neighbourhood, so it might be expected to use them as the fill materials. Such suggestion was already written in '76 of engineers on soil mechanics and geologiest. The soil volume is usually required to prepare 2 times of design volume.

c. Examination about rock or filter materials has not been finished yet, for their compression strength, grain·size distribution, location of pit and volume etc.

3) Foundation treatment

Treatments by mean of blanket or grouting have to be examined again.

4) Comment

At this point of time, it is troublesome to evaluate the result of borings and other surveys without detailed outcrop geological map by scale 1 : 500 (at least 1 : 1,000). And it was desirable to be carried out to look for the dam materials roughly at more wide ranging area on ealier stage.

EXTRACT FROM "SURVEY REPORT ON SELUMA PROJECT & AIR LAIS PROJECT, JUNE 1978"

3. Technical report on seluma project

3.1 Progress of construction works

The total amount of excavation of spillway is estimated to be approximate 1,060 thousand cu.m and approximate 670 thousand cu.m excavation out of these has been so far completed. A- shown in Fig. 2, excavation of spillway in the downstream of the first crest has been completed nearly at the designed cross section. In the upstream of the first crest, spillway has been remained temporarily excavated excepting about 50 m along Seluma river.

With regard to masonry concrete work, almost part of the second stilling basin (EL 10.5 m) has been completed. The work up to EL 19 m has been finished at the right bank side of the first stilling basin and the second crest, and it continues to place masonry concrete there. The total masonry concrete is estimated to be approximate 70,000 cu.m including retaining walls and intake structure. Out of them about 8,000 cu.m has been so far placed.

In the fiscal year 1978/79, masonry concrete of approximate 16,000 cu.m is scheduled to place for the two crests excepting the surface pavement works. (See Fig. 2)

3.2 Geological consideration on foundation of diversion weir and treatment of crack

According to the visual observation at the excavating jobsite, the strata at the spillway consist of the following three layers.

- Clay and/or silt in the upper layer (red), 2-5 m thick
- Sand and gravel containing cobble stones in the middle layer (red), 3-10 m thick
- Sand stone in the foundation (ash-colored) below EL 30-35 m

The foundation is sand stone on which weir, retaining walls and other structures will be constructed. The bearing stress and permeability are judged satisfactory enough for the foundations of structures.

With regard to crack or fault, it is reported that craks of 2 - 3 cm in width occurred on the excavated surface on the 2nd crest and the west side retaining wall of 1st stilling basin by the earthquake on November 9, 1977 and these cracks were not affected by the twice earthquakes in February 1978. According to the survey, these cracks are regarded as a same continous fault. The strike of fault plane (ie. the direction of line that the fault plane intersects the horizontal plane) is almost N 35° W, and the dip (ie, the angle between the fault plane and the horizontal plane) is almost 45° to EN direction. The width of opening of faultcaused by the earthquake last year are 0 - 5 cm but 1 - 2 cm on an average. There are no sign of displacement toward horizontal or vertical direction.

Generally speaking, the fault plane is not a perfect geometric plane but a fracture face simillar to a plane as a whole, therefore strike and dip changes partially and the continuity is only under the technical assumption as far as the extention can not be confirmed.

The fault crosses obliquely the excavated step near the right abutment of 2nd crest and is supposed to extend to NW direction and exposes on the excavated west retaining wall. Furthermore, it will extend to NW and is supposed to appear in the intake canal route. (See Figs. 3 & 4)

Judging from such situation, it may be possible for treatment to use ordinal way which has been applied for the fault treatment of dam foundation. That is, concrete plug and grouting are usually adopted for the fault larger than several ten cm in width. For small fault as found in this case, it is usually to remove the fractured or soften zone in the both sides of crack and to place wedge of mortar or concrete as deep as possible. (See Fig. 5)

The treatment above said is to strengthen shearing resistance and to regulate seepage for fractured zone. Therefore, no consideration is placed on vibration of huge rigid masses or the growth of great cracks caused by displacement of big earthquake.

Then it may be better to take some countermeasure, but seismic design is not always clear on such problem. For example as proposed at the meeting, it may be some-what effective to support structure by installing reinforced concrete beam (s) but it may be not economical.

It may be rather advisable to repair the breakdown of 2nd crest or intake canal if it occurs by big earthquake, which seems low in probability. In addition the base rock is sand stone, which belongs to soft rock and N-value of standard penetration test is more than 70. So settlement as on soft ground or liquidation as on loose sandy ground will not occur. In order to protect further weathering and erosion of the fissured surface, it is necessary to remove inadequate foundation and to promptly cover with concrete.

3.3 Available material for embankment of closure dam

A closure dam is necessary to be built for closing seluma river. The height of dam is estimated approximately 25 m. Type of the closure dam depends on available embankment materials which can be economically found at and/or i- the vicinity of the job-site.

In general, embankment materials consisting of clay or silt, which are rather impervious, are found in the vicinity of the job-site.

However, large amount of material suitable for pervious material to be used for rockfill dam can not be found excepting sands and gravel deposits on the river bed. Consequently, the following materials can not help being used for embanking the closure dam eventhough the characteristics are not necessarily excellent.

(1) Excavated materials from spillway

As mentioned before, the excavated material from spillway consists of the following ones.

- Clay and silt
- Sand and gravel containing cobble stones
- Sand stone which has been broken into coarse grain

According to the soil mechanical classification for 25 samples, the following results are reported.

Classification	Sample
MH	8
SM or Sc (?)	7
ML	4
CH or MH	5
CL	1

The above classification in general shows the following characteristics:

- Containing ratio of clay and silt is rather high
- Materials is rather impermeable
- Shearing stress is rather small, etc.
- Consequently materials belong to middle or low ranking in adequency for embankment

Besides, the typical soil mechanic characters are reported as follows.

Cohesion (C kg/sq.cm)	0.18 - 0.6 (0.4)
Angle of internal friction (ø°)	42 - 61 (53)
Natural moisture content (W_n %)	32 - 48 (43.3)
Optimum moisture content (W_{opt} %)	20 - 38 (29)
Max. dry density (r_{dopt} gr/cu.cm)	13 - 15 (143)

*): Figures in the parenthesis are the average values for each item.

In order to improve gradation and other characteristics, it is suggested to mix or to use rather coarse materials, for which sieve analysis, compaction and permeability test etc. will be required as well as comfirmation of available quantity.

The materials so far excavated from spillway is approximate 670 thousand cu.m and most of them have been placed in the original ground located in the left side of spillway. (See Figs. 6 & 7)

The materials which has been placed on the dam axis will have to be removed at the beginning of embankment works.

It is important to place or to stock excavated material by its property at places where no obstruction is worried for construction works.

(2) Terrace deposits at the left bank of seluma river in the immediately upstream of dam axis.

There are two terrace deposits as shown in Fig. 6 at the left bank of Seluma river in the immediately upstream of the proposed dam axis. The soil mechanic properties of which have being analized at DPMA Bandung.

The profile at test pit (TP - 4) is as follows according to our visual observation at the site.

(a)	Top soil (chocolate colored),	from surface to (0.1 - 0.15 m)
(b)	Clay and silt (red),	(0.1 - 0.15 m) to (app. 2 m)
(c)	Sand and gravel (red),	(app. 2 m) to (app. 4 m)

It is judged the materials of (b) and (c) can be used for embankment materials if there are mixed and excavated by appropriate excavators.

The hauling distance is about 2.5 and/or 3 km through the existing road, and it will be about 1.5 km if access road including temporary bridge is built for hauling materials.

3.4 Type of closure dam

Since a large amount of pervious material or rock material is not obtainable in the vicinity of project area, it is difficult to economically construct rockfill type dam which is superior in stability.

Judging from available materials described in 3.3, so-called homogeneous type is adequate for the closure dam.

Taking into consideration the following items, the design of closure dam is required to re-study. (See Figs. 7 and 8)

(1) Design flood shall be $\underline{1.2 \times Q_{100}}$ which is nearly equal to Q_{500} in this case. Free board shall be more than 1.0 m. Flood discharge during construction shall be Q_5.

(Suffix of 500,100 & 5 means the return period in year of each discharge).

(2) Taking into consideration the fact that materials contain much more fine particles rather than coarse ones, the upstream and down stream slopes shall be such mild slopes as these are 1 : 3.5 and 1 : 3.0 respectively based on various precedents.

(3) Relatively coarse materials than the middle part of dam shall be used in the up and downstream shoulders. Regardless of materials, compaction work at the job-site shall be performed so that maximum density could be obtained nearly at the optimum moisture content.

(4) Toe drain at the toe of downstream slope shall be constructed with pervious materials so as to lower seepage line and to assure stability of the closure dam.

(5) Rip-rap shall be placed on the upstream slope.

(6) There are found in the right bank of Seluma river at dam axis the river deposit containing cobbles and gravels. Cut-off consisted of impervious material shall be installed below the center of dam in the said river deposit.

The width of cut-off contacting with the foundation shall be 15 m which meets approximate 50 % of water pressure.

(7) Filter materials shall be necessarily placed at the contact parts with rather impervious material and river deposit, toe drain and rip-rap.

(8) In the previous report (our ref. No. 7849 dated 18, April), an alternative dam axis was proposed. It is judged according to the field survey that there is no difference in conditions of design and construction etc.

As above mentioned, mild slopes are proposed due to the property of materials. Therefore it is foreseen that embankment volume will be greatly increased than original design with steep slopes. In order to study construction method and construction schedule, required embanking volume shall be estimated after finalizing the dam crest and assumed foundation surface.

3.5 Diversion channel to be constructed in spillway and weirs

In the light of increasing of embankment volume, embankment capability and workable days etc, it is foreseen that the construction period of closure dam my be more than two years.

For a period during which Q_5 can be released through the river bed left unbanked, the diversion channel (app. 100 sq. m) is regarded as a reserved spillway for releasing run-off in the dry and the wet season. However, after progressing embankment and reducing the river bed which is used for releasing flood, the proposed diversion channel is necessary for releasing river run-off.

In addition, the diversion channel can be used for releasing the discharge in dry season in the last year when the river bed left unbanked is closed last.

On the other hands, since completion of embankment will meet the end of dry season in the 2nd year and/or later, water level will suddenly rise in the forthcoming wet season. This is not necessarily favorable in view of safety of dam immediately after its completation. It may be necessary to occasionally lower the water surface through the diversion channel which is regarded as an emergency outlet.

Therefore, it will be also necessary to regulate river run-off through the diversion channel for at least a wet season after the completion of closure dam.

In the previous report, mild slope for the excavating the diversion channel was proposed. According to this field survey it was confirmed the geology thereof is of stone where perpendicular excavation be nearly performed.

3.6 Design of retaining wall

In the original drawing of cross section III, IV, V and VI of retaining walls, cut-offs each having 4-8 m in depth are designed.

Most of retaining walls are constructed on or in the sand stone which is located below about EL 30-35 m. Bearing strength and anti-permeability of the sand stone is judged satisfactory according to this field survey. If retaining walls be placed on or in the sand stone, so deep cut-off is not necessary. Therefore, it is required for each cross section to confirm the elevation of sand stone foundation and to re-study whether cut-off be necessary or not. In addition, in order to drain ground water behind retaining walls during and/or after construction, weep holes are suggested to install at H/3 in heigh of walls and 0.3 - 0.5 m above normal high water level spacing 5 m.

3.7 Downstream apron and rip-rap

The diversion weir of Seluma project consists of two crests, two stilling basins and dissipator works (baffle piers or notched still). Satisfactory results have been reported for energy dissipation and anti-scouring according to the hydraulic model test made by DPMA. However, there are many examples of diversion weir encourtering with scouring problems just downstream of fore-apron in Indonesia. These damages will be caused by shortage in length of fore-apron or lack of rip-rap.

Since the difference in elevation becomes 22.5 m from the 1st crest (EL 33.0 m) to the second basin (EL 10.5 m) in Seluma Project, rip-rap work (such simple structure as wired mattress or cylinder etc.) is suggested to install next to the fore-apron, even hydraulic model test could provide good result for scouring problem.

3.8 Mixture of embankment materials and test embankment

In case that borrow area consists of strata of clay, sand and gravel and sand stone etc. as seen in Seluma Project site, several samples of mixture design shall be selected for finding adequate mixture materials to be used for embanking after conducting soil characteristic analysis such as gradation analysis, permeability and compaction tests etc.

Besides, test embankment is generally performed prior to the actual construction works. The test embankment is to sound allowable water content, spreading thickness and compaction method etc., based on which construction control at job-site is conducted.

In the construction work of fill dam, control of water content and compacting works are important based upon technical specification etc. It is also necessary to take into account satisfactory mobilization of equipment so that work cycle of excavating, hauling and compacting can be smoothly conducted at job-site.

3.9 Care of river during construction and construction schedule

With regard to the subject matter, the basic three conceptions have been proposed in the previous report.

Explanation and discussion on these conceptions was made as follows at the meeting held in Bandung May 30th.

That is:

a) Sillway, diversion weir and intake facilities etc. are constructed by Coupure method closing the both ends of spillway regardless or river run-off. In parallel with them, embankment work is conducted.

   Masonry and embankment works are finished by the beginning of wet season in the second year, flood discharge of which is switched to the spillway. In this case, riber run-off is released only through the river channel which is left unbanked.

   (Half-enclosure method)

b) Embankment work is conducted in parallel with masonry works for spillway, weir and intake etc.

   However, masonry work of the crest is remained unplaced and notched shape so that flood in wet season of 1st year can be released through this part including the diversion channel even if flood intrude into the spillway. Fulfilling of the notched part is conducted in the 2nd year under the assumption that embankment could be completed at the same time.

   In this case, river run-off during construction is repleased through the unbanked river bed and the spillway including diversion channel.

(Diversion channel method)

c) After completion of spillway, diversion weir and intake facilities, ie; after completely providing function of spillway, embankment starts independently.

In this case, river run-off during construction is released through the spillway including the diversion channell and river bed left unbanked.

(Spillway and Half-enclosure method)

In the course of discussion, main problems pointed out by the participants were as follows.

(1) In case of a), embankment in the 2nd year will be tight in work schedule. The construction period depends on actual construction capability and it will take more than 2 years for construction period.

(2) In case of b), masonry in the 2nd year will be tight in its work schedule, as well as embanking as stated above.

(3) An alternative was proposed as follows.

- First, spillway including diversion channel is constructed up to EL 30 m, and masonry work is suspended at the said elevation.
- Embankment of closure dam starts
- After completion of embankment, masonry works higher than EL 30 m starts again

According to a rough estimation on the volume for the dam type stated in 3. 4, it is foreseen that the volume will greatly increase than our first approximation due to modification on the elevation of dam crest and the bothside slopes.

Estimation of dam volume is first necessary for study on construction period and construction method modifying said basic conceptions including an alternatives.

3.10 Others

(1) In order to perform satisfactory construction supervising, the latest drawings which are approved by the authority concerned shall be available at their hands in the site-office. DPUP and/or Directorate of Irrigation shall always pay attention for providing the latest drawings to the site-office.

(2) Water level guaging staff installed at the beginning of construction work has been left broken.

It is suggested to install it again for measuring water level and to prepare Q - H curve at the site as soon as poss-ble. The actual recording of water level or discharge is useful for verifying the existing data or the estimated data used for planning or designing and it is also useful for providing precious data for future projects in the vicinity, even it is only for a few years.

4. Technical report on air lais project

In the course of excavating the foundation of diversion weir, a 5 m or 8 m thick layer consisting of lots of big size rolling stones having 1.5 - 2 m in diameter has been found between clay, sand and gravel layer and the foundation on which the weir is built. Excavators and manual labours have faced to difficulties for excavating or removing the said big size stones.

The site-office and the contractor is planning to use blasting but they are worried about damage to the structure foundation.

In general, quantity of powder or spacing of drilling will be estimated by empirical formula for large scale blasting. However, such formula are not applicable for the strata irregularily contained lots of big size rolling stones encountered in Air Lais Project.

So blasting shall be conducted one piece by one piece by increasing or decreasing the quantity of powder. Especially for the stones near the foundation, the quantity of powder shall be prudently selected in the light of actually used powder.

Occasionally two trial tests were conducted, the one was for the stone on the ground, another for the stone in the ground using about 0.5 kg of powder per each piece. Satisfactory results have been reported. Consequently it is suggested to start blasting one by one based on the said test results which could provide previous precedents for next blastings.

In addition, there are many peoples working or living at or near the job-site. Prior to Blasting, precautions shall be necessary so that they can take refuge from danger due to blasting.

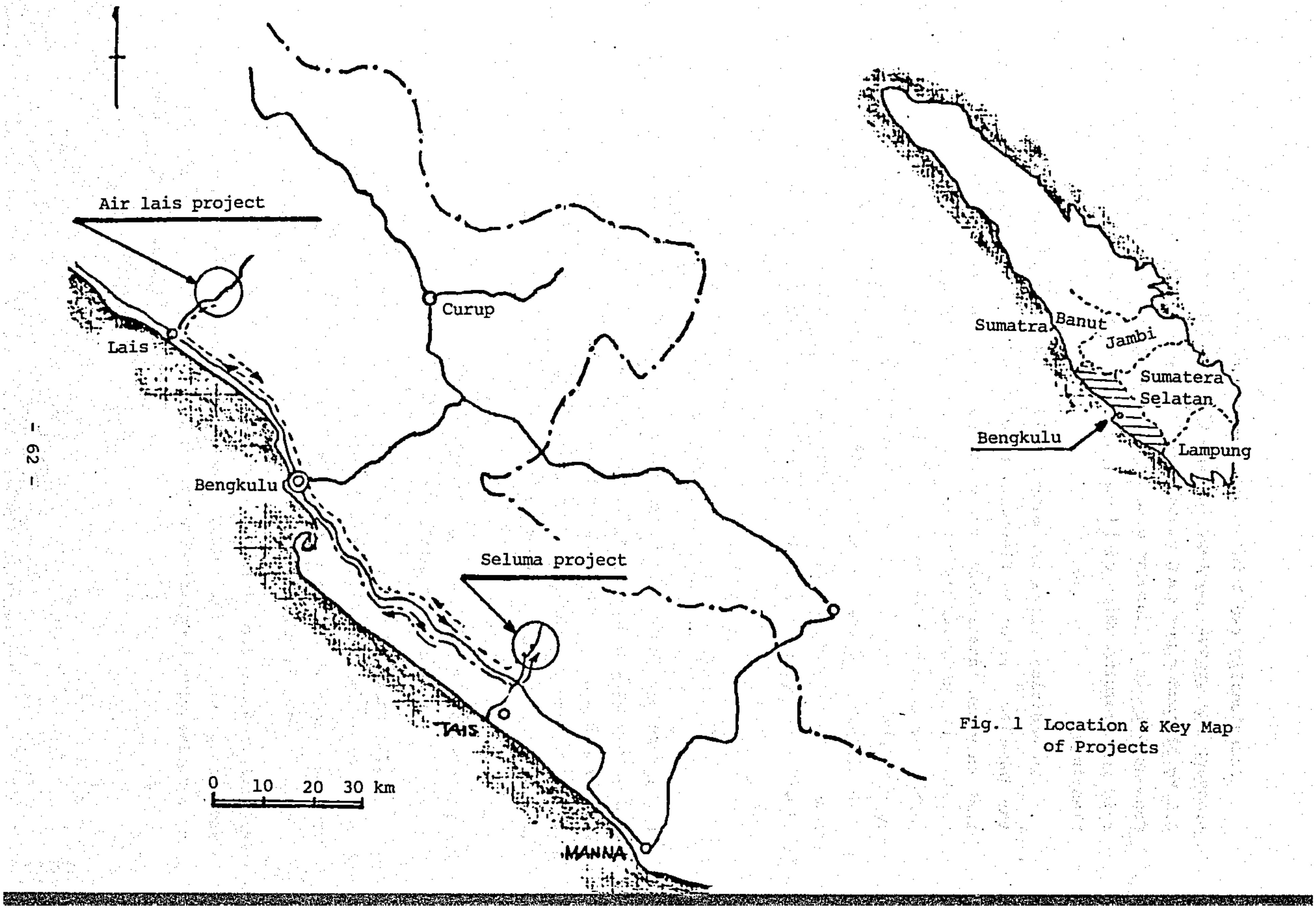


Fig. 1 Location & Key Map of Projects

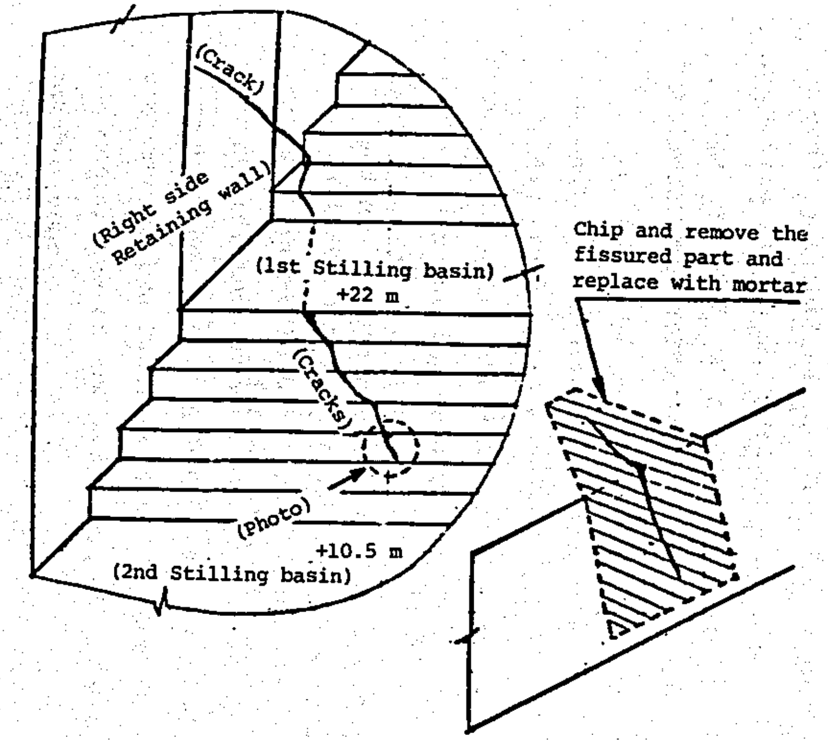


Fig. 5 Sketch of Cracks and its Treatment

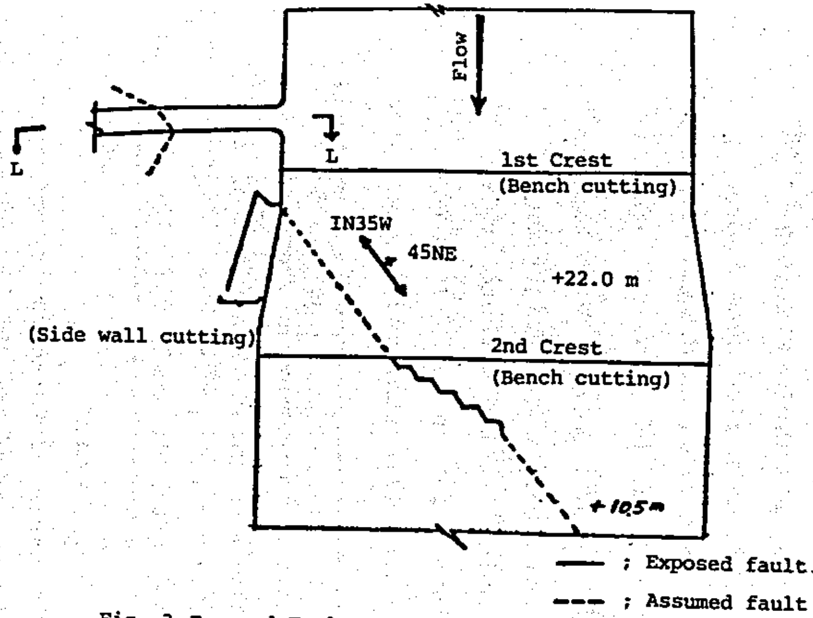


Fig. 3 Exposed Fault

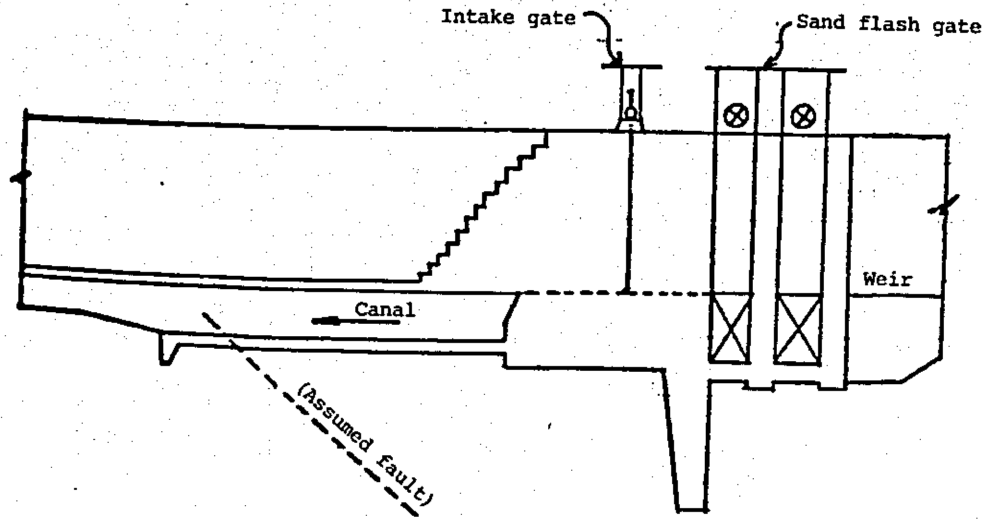


Fig. 4 A ssumed Fault in L-L Section

REPORT ON FIELD SURVEY FOR TEUPING RAYA WEIR, MAY 1978

1. Purpose of field investigation

At the request of Director of Irrigation, Colombo Plan Experts N. Yamada (Design & Planning Service Directorate of Irrigation, Bandung) and Dr. K. Uno (Design & Planning Service Directorate of Irrigation, Bandung) made the field investigation for Teupin Raya weir accompanied by Mr. Hasan Basri B.I.E. (Jakarta) and Ir. Santjojo (Bandung).

The purpose of field investigation is to observe the present condition of the settlement of the said weir and to study on how to cope with the situation.

2. Schedule of field investigation

The schedule of Field Investigation was as follows.
At Banda Aceh, Ir. M. Thahir (Chief of Provincial Public Works Service D.I. Aceh) and Ir. Soenoto (Chief of Water Resources Division, Provincial Public Works Service D.I. Aceh) made explanation on the situation, and Ir. Ismail (Chief of Krueng Baro Project) and Ir. Sabirin (site engineer Krueng Baro Project) participated in the field and Technical explanation on the problem were provided.

May 23	:	From Bandung to Jakarta
24	:	From Jakarta to Banda Aceh
25 - 26	:	Field Survey
27 - 28	:	Collected the data, and discussed on the situation and the counterplan
29	:	From Banda Aceh to Jakarta
30	:	From Jakarta to Bandung

3. Summary

Teupin Raya weir site is located about 20 km to the South-east of Sigli, Daerah Istimewa Aceh. It was constructed in 1917, for irrigation to the 1250 ha paddy field (100 ha in the right side, 1,150 ha in the left side). The discharge of intake is 1.3 m^3/sec (0.1 m^3/sec to the right side, 1.2 m^3/sec to the left side). The mean rainfall is as Table -1, -2. The discharge of the river is not so enough to yield two crops a year.

Table -1. Mean Rainfall

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Sigli	234	155	140	145	89	47	54	53	70	136	234	279	1,636
Meureudoe	193	162	149	127	90	62	45	56	89	154	203	241	1,571
Lam Meulo	251	196	215	185	141	66	44	87	139	205	238	246	2,013

Table -2. Mean Daily Maximum Rainfall

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Absolut Maximum	Max. next but one
Sigli	64	54	45	48	35	22	28	23	25	42	64	68	185	175
Meureudoe	63	54	48	46	45	26	23	25	36	54	66	78	253	175
Lom Meulo	72	66	60	45	46	27	20	30	41	50	58	65	185	142

In 1920, the weir was destroyed by the civil war and in 1921, the provincial government presented a request to reconstruct the weir which included the opinion to change the location to 30 m upstream and to make higher the water level of the intake. In 1923, the previous sliding timber weir was improved to sluice gate and the water level of the intake was made 2 m higher.

In 1936, 5 m fore apron was added and downstream revetment was extended. During 1936 to 1953, since the break of the fore apron was remarkable, the farmers repaired it by filling the gravel into the cracks. However, they could not stop the break of the fore apron, therefore they constructed two lines wooden stockade at 3 m and 20 m downstream from the centerline of the weir, but at present, only several wooden piles can be found.

February 17, 1978, the gates could not be moved, the drop of water level at upstream of the weir was remarkable and welling up the water from the downstream of the weir was found. After the investgation, three holes (diameter 3 - 5 m, depth 4 - 5m) were found at the river bed of the upstream of the weir between the center of the piers.

In a week from February 24, 3250 sandy soil bags (total volume is about 200 m^3) were filled in the holes.

4. Present conditions

A. The settlement

The result of leveling at the field is as Fig. -4.

Assuming that the right side abutment does not settle.

The biggest settlement of the piers is about 13 cm and one of the apron is about 12 cm. The difference between the highest point and the lowest one is about 15 cm on the piers and about 21 cm on the apron. All piers lean toward upstream.

B. Remarkable Cracks

Remarkable cracks are as Fig. -3.

There are large cracks in the downstream side of the part of over flow.

The crack of the lower part of the center pier is considerably large and makes around the pier. It will be deep.

It seems that there are many deep cracks on the fore apron, but they could not be confirmed on account of water.

There are cracks around the upper structures of both side abutments.

C. Condition of under the apron

On account of water, we could not investigate the condition of under the apron. Considering the volume of sandy soil bags which were filled in the holes of upstream of the weir, they must not be filled under the apron. It was said that some sandy bags appeared downstream of the weir when they were filled into the holes, therefore, considerable big holes may be under the apron.

D. Geologic and soil mechanic condition

The strata which exposed on both side of river near weir are alluvium. The layers of silt and fine sand of 3 - 5 cm in thickness lie one upon another alternately and form so called alteration of strata. These sedimentary strata appear almost horizontally on the cliff of both bank.

The strata of 3 - 4 m depth from surface are weathered, brownish colour, very loose and soft. The ones under them are unweathered, bluish grey colour and their texture are not deteriorated. Among these alteration of silt and sand layer, a sandy layer bearing gravel appears.

The brownish yellow and weathered zone near surface lacks its stability and failures of slope occur on both side of almost all parts of River Teupin Raya. At the neighboring part of weir, the failure is eminent on right bank and a spring comes out from it slide boundary but not so much on left bank, so the layers are conceivable to dip only a little toward left and downstream.

At 1 km upstream from the weir, a new road bridge is now constructing and the data of its foundation survey (Dutch corn penetration test) can be available. As these alluvial sediments may be considered to continue almost horizontally, the result of test may be possible to correlate to the strata of the weir site. The estimated relation is as follows.

Zone	Depth from surface (m)	Bearing capacity by test (kg/cm^2)	Allowable bearing capacity (t/m^2)	Geological correlation
1st zone	To 3 - 4	Under 10	Under 2	(Weathered zone) Very loose sand or softy clay
2nd zone	From 3 - 4 to 5 - 7	50 - 80	10	(Unweathered zone) Medium hard sand or hard clay
3rd zone	From 5 - 7 to 17 - 22 (extent of test)	10 - 30	5	Supposed to loose sand or medium hard clay

The 1st zone and 3rd zone have characteristics of poor ground or near to poor ground. The 2nd zone can barely support the pier but has not safety bearing capacity for it. As mentioned later, the difference settlement of weir is mainly caused by piping but also the bearing capacity can't be said to satisfactory enough.

E. Operation of the gates

In February, the first gate (the right side gate) could be moved creakily. The second gate was impossible to operate and the third and the fourth (the left side gate) gates could be operated normally. But at present, only the fourth gate can be operated normally and others are impossible to operate.

5. Consideration

A. Cause

(a) Path of percolation

According to Bligh's formula

$$S \geq c\,\Delta h$$

S : Path of percolation

Δh: Difference of hydrostatic head between upstream and downstream = 7.5 m

c : Bligh's Coefficient

It is difficult to estimate the nature of the soil under the apron but assuming that Bligh's coefficient is 7, it may be too small, the necessary path of percolation is as follows.

$$7 \times 7.5 = 52.5 \text{ m}$$

nevertheles, actual path of percolation is only 24 m.

(b) Thickness of apron

According to next formula

$$T \geq \frac{4}{3} \frac{\Delta h - h}{r - 1}$$

$$h = \frac{\Delta h}{S} S'$$

T : Thickness of apron

r : Specific gravity of material of apron

Δh: Difference of hydrostatic head between upstream and downstream

S : Path of percolation

S': Path of percolation until the said point

The necessary thickness of apron at right downstream of the piers is as follows,

$$h = \frac{7.5}{24} \times 9.6 = 3.0 \text{ m}$$

$$T = \frac{4}{3} \times \frac{7.5 - 3.0}{2.3 - 1} = 4.6 \text{ m}$$

nevertheless, actual thickness is 1.0 m.

B. Consideration on the cause

At first according to shortage of the path of percolation, water flowed down under the apron and spouted out from the right downstream of the apron. It will be reason why the fore apron was added 5 m in 1936. Moreover, owing to shortage of the thickness of apron, uplift pressure made many cracks on the fore apron and water spouted out from them. Therefore, it made the path of percolation shorter than shorter and made the stream of water easily. On account of this typical piping, the soil and sand of upstream and under the apron had been flowed away. Thus, it made big holes at upstream of the weir, and there may be holes or porous soil under the apron. Probably it is the cause of settlement of piers.

On the other hand, considering from that the settlement of the piers is small compared with the depth of holes and that the weir kept function for sixty long years, it is supposed that the soil under the piers is consolidated by the load of the piers and has considerable bearing power, therefore it is hard to flow away.

However, until February in this year the settlement of piers was not perceivable, but now it can be seen with eyes.

It shows that the settlement of the piers was accelerated rapidly in this three months. It is very dangerous condition, therefore if weir is not repaired without delay, it is feared that the weir will be not only unavailable but fallen down in next season.

6. Countermeasure

A. Temporary repair

As mentioned above, the greater part of the settlement of the piers made rapid progress in this three months, it is calculated as 3 cm a month. Consequently, it will be impossible to use the weir safely in next wet season. As a matter of course, it is necessary to take countermeasures which can be made in four months until the beginning of the next wet season.

(a) Design of apron

(1) Path of percolation

The condition of the soil under the apron is not confirmed, but considering from that this countermeasure is temporary and that the weir has kept function for sixty long y years, in spite of fear too small for permanent construction, assume Bligh's coefficient 7.

$s = 7 \times 7.5 = 52.5 \doteqdot 53$ m

vertical path of percolation is $8 \text{ m} \times 2 - 2 \text{ m} = 14$ m

Therefore the level path of percolation is,

$53 \text{ m} - 14 \text{ m} = 39$ m

(2) Length of fore apron

According to Bligh's formula

$l = 0.6\, c\sqrt{h}$

$= 0.6 \times 7\sqrt{7.5} = 12 \text{ m} - 15 \text{ m}$

(3) Thickness of fore apron

$$h = \frac{\Delta h}{S} \times S'$$

$$= \frac{7.5}{53} \times 42 = 5.94$$

$$T = \frac{4}{3} \; \frac{\Delta h - h}{\gamma - 1}$$

$$= \frac{4}{3} \cdot \frac{7.5 - 5.94}{2.3 - 1} = 1.6 \text{ m}$$

(4) Length of protection of downstream bed

According to Bligh's formula

$$l_f = 0.67\, c\sqrt{\Delta h.q}$$

l_f : Length of protection of downstream bed

q: Designed flood discharge per unit width

$q = Q/B$

B: Width of river = 25 m

$$Q = \frac{1}{3.6}\, f.\gamma.A$$

Q: Design discharge

f: Run off coefficient = 0.8

γ: Design rainfall intensity

A: Catchment area = 60 km^2

$$\gamma: \; \frac{R}{24}\left(\frac{24}{T}\right)^{\frac{1}{2}}$$

R: Design daily rainfall = 175 mm/day (from table -2)

T: Concentration time of flood

$T = 1/\bar{W}$

1: Length of river from the upmost point to the weir site

= 15 km

$\bar{W}$: Spreading velocity of flood

$$\bar{W} = 72\left(\frac{H}{1}\right)^{0.6}$$

H: Difference in elevation between the upmost point in the catchment area and the weir site = 0.1 km

$$W = 72 \frac{0.1}{15}^{0.6} = 3.56 \text{ km/hr.} \quad T = 15/3.56 = 4.21 \text{ hours}$$

$$\gamma = \frac{175}{24}\left(\frac{24}{4.21}\right)^{1/2} = 17.41 \text{ mm}$$

$$Q = \frac{1}{3.6} \times 0.8 \times 17.41 \times 60 = 232 \text{ m}^3/\text{s}$$

$$l_f = 0.67 \times 7\sqrt{7.5 \times \frac{232}{25}} \doteqdot 40 \text{ m}$$

Accordingly the diameter of apron is as Fig. 5

(b) Temporary repair

Two ways how to repair will be considered.

A way: After removal all piers, drive foundation piles, and construct them newly

B way: Driving the steel sheet piles two lines at upstream and downstream, fill the sand and gravel in the space under the apron and between two lines of sheet piles. After placing apron concrete, reinforce the foundation by grouting.

The progressive schedule on two ways are as Fig. 6

In this schedules, what is assumed is as follows.

Efficiency to drive foundation sheet pile: 6 m/day
Efficiency to drive temporary sheet pile : 10 m/day
Efficiency to excavate: 3 m^3/day x 20 persons = 60 m^3/day
Efficiency to place concrete: 30 m^3/day
Efficiency to remove a pier : 7 days/1 pier

Discharge in course of construction is as follows, assuming daily rainfall is 30 mm from the mean daily maximum rainfall in dry season in Table 2.

$$W = 72\left(\frac{H}{l}\right)^{0.6} = 3.56 \text{ m/sec}$$

$$T = l/W = 4.21 \text{ hr}$$

$$\gamma t = \frac{30}{24}\left(\frac{24}{4.21}\right)^{1/2} = 2.98 \text{ mm}$$

$$Q = \frac{1}{3.6} \times 0.8 \times 2.98 \times 60 = 39.73 \text{ m}^3/\text{sec}$$

To flow down from one gate 4 m length,

$$Q = C.B.H^{3/2}$$

$C = 2 \quad B = 4\text{m} \quad H = 3\text{m}$

That is, the height of temporary sheet piles is 3 m.

Needless to say, A way is free from danger after construction and desirable, but B way is more practical by reason as follows.

(1) Delay of works is not estimated in this schedule, but the term to need to keep dry condition is long in A way. Since there is no time to spare in A way, if a hindrance for the work occurs, just like flood or delay of preparation of equipments, material or labour and so on, it is impossible to complete until the next wet season. About one or two months delay must be estimated in the case of A way. While, since grouting is possible to continue whenever the condition is good, B way has adaptability in schedule.

(2) An explosive is necessary to remove a pier in seven days, using another way considerable many days will be necessary.

(3) A way is also a way to repair temporarily. If we hope to make a permanent construction, it is necessary to study more on foundation condition and to repair the abutments because some swelling was found in the left side abutment and considerable large cracks were found in the upper part of both abutments. Therefore if piers and apron are reinforced and abutments are kept as it is, abutments will fall.

As mentioned above, B way has adaptability in schedule and it is suitable for temporary repairs, but it is necessary that an experienced engineer studies the condition of works and suitable method always during the construction works. Since grouting is not almighty and has many uncertain factors, B way is inferior to A way in safety. It is impossible to forecast how bad effect driving sheet pile exerts and to reform the settlement, the inclination and the cracks of piers, therefore if delay of intake is permitted, the safe A way is desirable. The rainfall in October and November is about two times of rainfall in dry season, but using two gates for discharge is possible.

However, since the number of rainy days increases, without preparation of enough drainage pumps, completion will delay still more.

For the present, aiming at taking water in September, B way is recommended but matters that demand special attention are as follows.

(1) At present, the maximum settlement of piers is 3 cm at first. To protect this settlement, drive the sheet piles at first, after that, fill the sand and gravel under the apron. Since the sheet piles are driven near the piers, it is necessary to do measuring the settlement always.

From the safety to fall, assuming the safety factor is 3, the allowable difference between upstream end and downstream end of a pier by leveling is 50 cm, and between right end and left end is 5 cm.

(2) The sand and gravel which fill under the apron and between the two lines of sheet piles must be filled as inner as possible.

(3) The parts where many cracks are found on the apron between two sheet piles line should be removed and from there fill the sand and gravel.

There are large cracks at the parts of overflow weir, since that parts have 3 m in thickness, if it is impossible even if make efforts to remove them, cut the concrete surround the cracks in V type and fill the cement mortar in it.

(4) It is supposed that the fore apron has many cracks or flows away, therefore remove all of them and kneaded soil and replace the concrete.

(5) It is necessary to repair the gate guide rails which make impossible to move the gates. Cut the wide and deep grooves and fix the steel gate guide rail welded reinforcing bar, fill the cement mortar into the space. This works should be done after grouting. It will be necessary to adjust the gates and to attach gum plate to stop water to the gates.

(6) Since the gates and the spindles are in danger of distortion, it will be necessary to make free as soon as possible.

(7) It is necessary to continue the observation even after completion.

(c) Grouting

The purpose of grouting are the improvement of bearing capacity and the curb of seepage. But in this case, going so far to say, the operation is to fill the underground hollow that enclosed by sheet piles and the condition enclosed is unknown. So it is differ in some points from ordinal grouting for dam foundation and the term of works is restricted. Therefore it is dispensable that an experienced specialist adopts suitable method to meet the situation. I say the following by way of suggestion from the private impression at field site.

(1) The most important point is the filling in the cavity with gravel and sand as much as possible before grouting. If dewatering after sheet piling is not dangerous, it is desirable to see the underground condition practically and to consider the fit method for filling and grouting.

(2) In case that a rotary boring machine is used, it is desirable to get data as same as geological boring (e.g. about the description of profile, hardness, vacant space, return ratio for supply water coefficient of permeability etc.)

In the case of percussion boring machine (drill), the information of material, crack etc. must be recorded for reference of grouting as far as possible. At least, the amount of permeable water before grouting is necessary to know by water inject test under the fixed condition (e.g. length of section (2 m), pressure of water (2 kg/cm^2) and period (5 minutes).

(3) The disposition of grout holes can be considered by several way. One example is shown in Fig. 7 (a). Groutings are operated in order from 1st group and, 2nd group and so on and injected at their middle point between previous ones. The grouting pattern may be modified sometime from the result of grouting.

When the inclined hole is unavoidable because of the carried machine and existing structure, the positions must be selected to fill the space evenly.

(4) As the settlement of the right pier is the largest and probably effects the other settlement, it is conceivable to take the pattern shown in Fig. 7 (b) to give the priority of reinforcement around the pier at the beginnings, after that, grouting shift to other holes.

(5) The depth of grout is made as the same length of sheet pile (6 - 8m). The length of stages is decided from the result of water inject test. There are instances grouted by every 0.5 - 1.5 m length for much fissured rock. The priority of grouting hss to be given to the disturbed zone shallower than 5 m.

(6) It is perhpas necessary that the grout materials are mixed with sand or clay for filling of many big cavities at beginning. When the coagulation of that grout begins, after washing by water, grouting of cement milk is carried out.

(7) Grouting pressure is ordinary 1 kg/cm^2 or so in such shallow depth, but the object is enclosed by sheet piles and slab,

so maximum pressure may be decided by trials. However, setting of air escape hole may be effective at beginnings.

(8) About the finish of grouting, there is an example that it is closed when the inject amount becomes 0.1 - 0.2 ℓ/min/m in some consolidation grout. But it is also up to engineer's judge based on practical operation.

B. Position of new weir

Since the reparation mentioned above is temporary, it is unfit for using for a long time, therefore, it is necessary to construct new weir in a short time.

Investigating to 2 km upstream from the existing weir, the condition of river is just like the existing weir site, it has no flood basin and depth is large compared with width, the slope of both side of the river is steep and landslides are found in several places. Consequently, if the new weir is constructed in the river, like the existing weir, we can't but construct the gate type weir, but considering from the geological conditions, it is disagreeable to construct the piers having heavy load. The width of the river too narrow especially in wet season to construct by closing a half width of the river. Therefore, considerable wide and deep diversion channel will be necessary. For that reason, Coupure method may be the most suitable. A location suitable for coupure method is about 2 km upstream from the existing weir. Although the canal to connect with the existing canal may be long, the advantages are as follows.

(1) It is possible to extend the benefited area. The river discharge may be not enough, but adjoining Tiro river has 10 m^3/sec discharge even in dry season. At present a gabion weir was constructed already and take 7 m^3/sec irrigation water for 6,300 ha from the gabion weir, therefore there are at least 3 m^3/sec surplus discharge. There exists a canal and the length of canal from the gabion weir to the upper stream of the Teupin Raya river is about 6 km. The elevation of the gabion weir is 80 m and one of the Teupin Raya river at the end of the canal

is 57 m, since the 3 m^3/sec discharge can flow into the Teupin Raya river by extend the existing canal, it possible to irrigate this discharge for the benefited area of the new weir considering two times crops a year. But the gabion has been destroyed two times by flood, it should be reconstruct to concrete weir. Well foundation method will be suitable because there exist 3 m layer of gravel on the rock.

(2) It is possible to continue the construction works safely and certainly.

(3) By construct a low fixed type weir, it is possible to keep stability and to economize the cost of the construction, the operation and the maintenance.

Estimating roughly the width of the new discharge channel, it is as follows.

Assuming the designed flood discharge is 230 m^3/sec, overflow depth is 2 m and the length of fixed weir is 20 m.

$$Q = C\ L\ H^{3/2}$$

$$= 2 \times 20 \times 2^{3/2} = 113\ m^3/sec.$$

Assuming the length of the silt ejector is 6 m, the necessary overflow depth to flow down the discharge of 117 m^3/sec (230 m^3/sec - 113 m^3/sec) is about 4.6 m from the formula above.

Therefore, the width of the new discharge channel is estimated as 26 m, but since this is the rough estimation, it is necessary to study designed intake elevation, ground elevation, river bed elevation and slope, design flood discharge, etc.

Nevertheless, it is about right that the width of new discharge channel can be estimated nearly one of existing river, and using some low roll type gate will make it possible to shorten it.

Fig. 1 Location of Teupin Raya Weir Scale 1:250.000

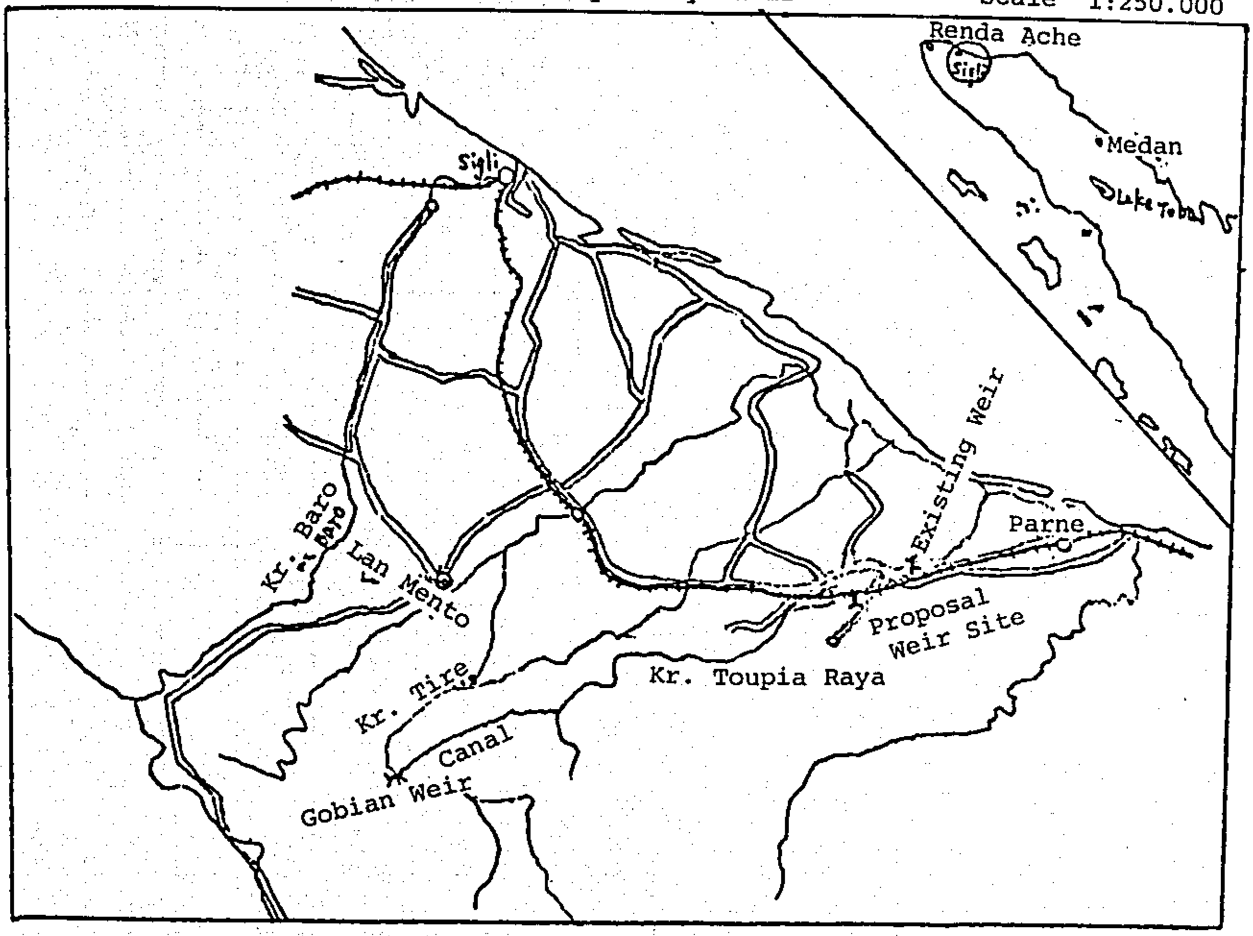
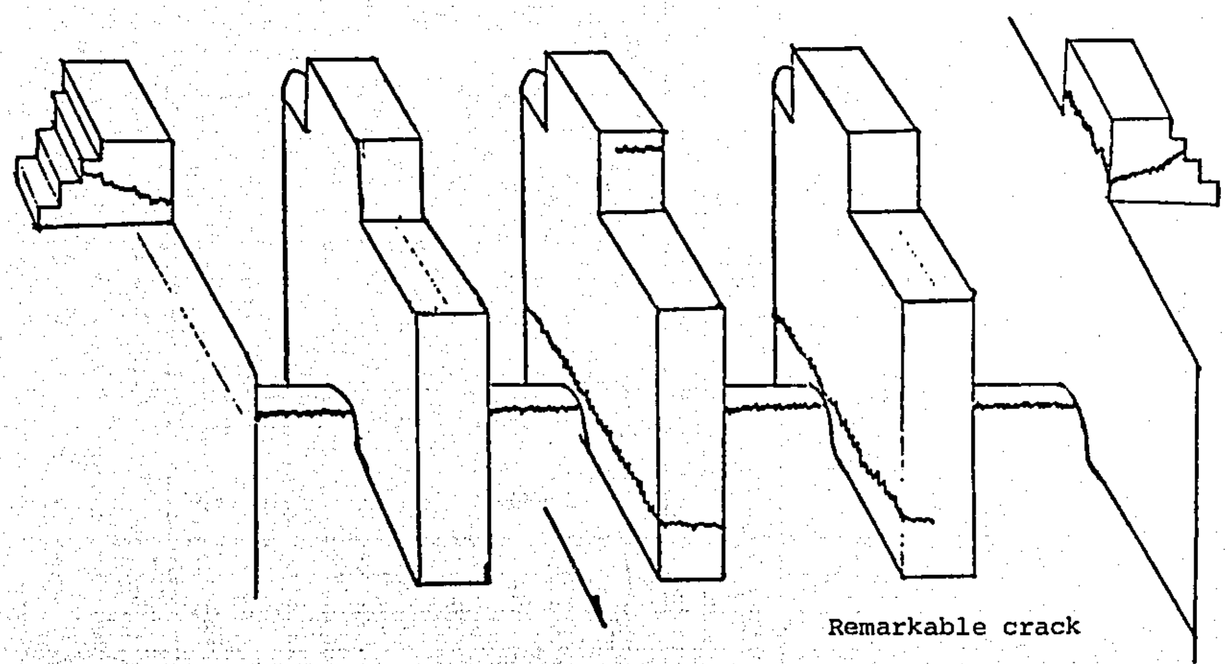


Fig. 3 Remarkable Cracks



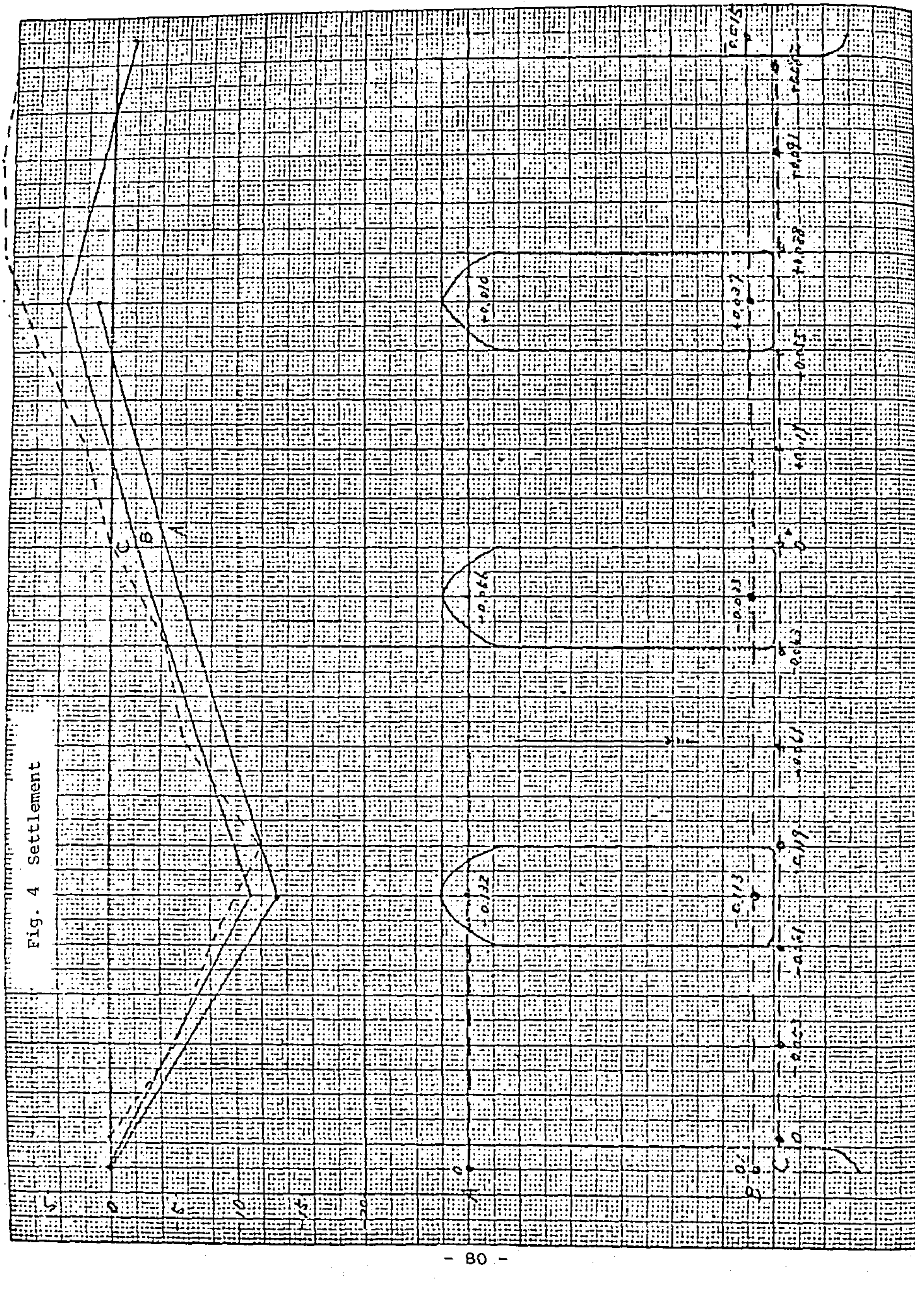


Fig. 4 Settlement

Fig. 5 Design of Aron

Scale 1:200

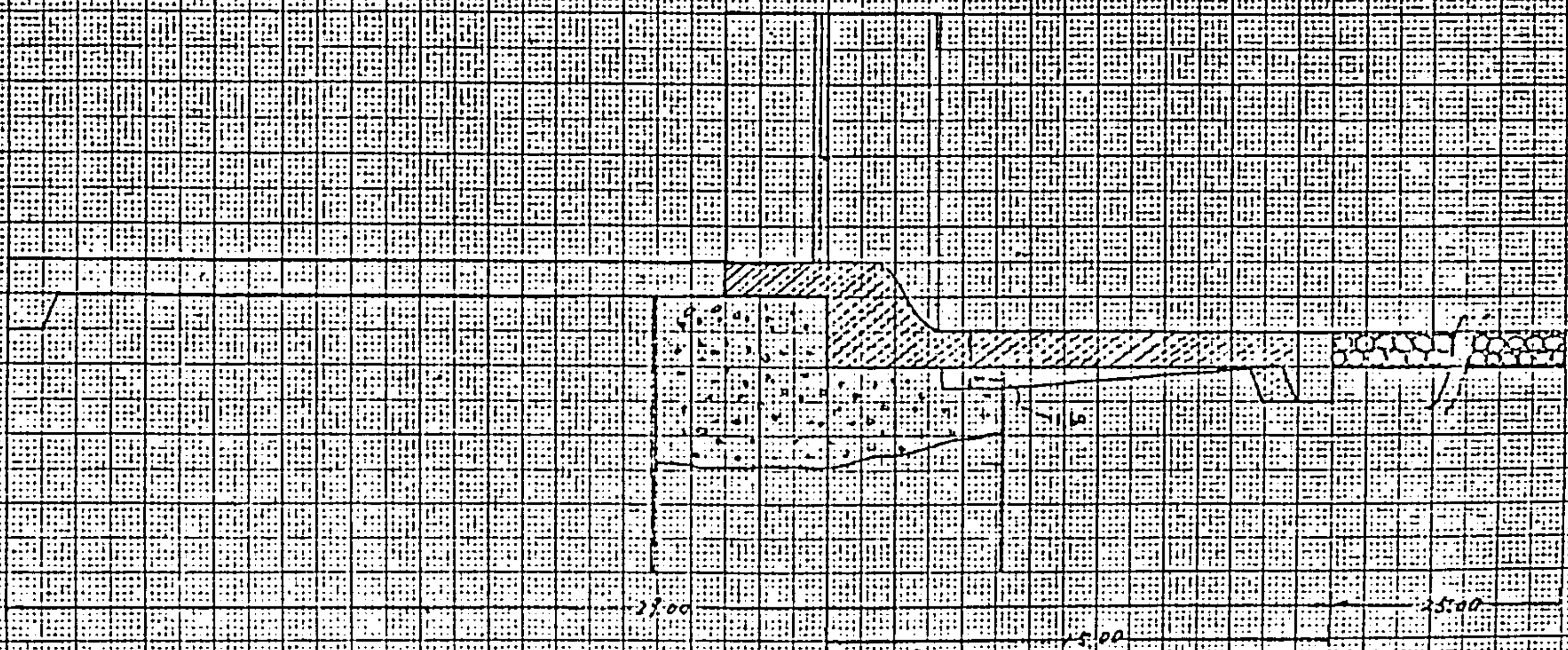
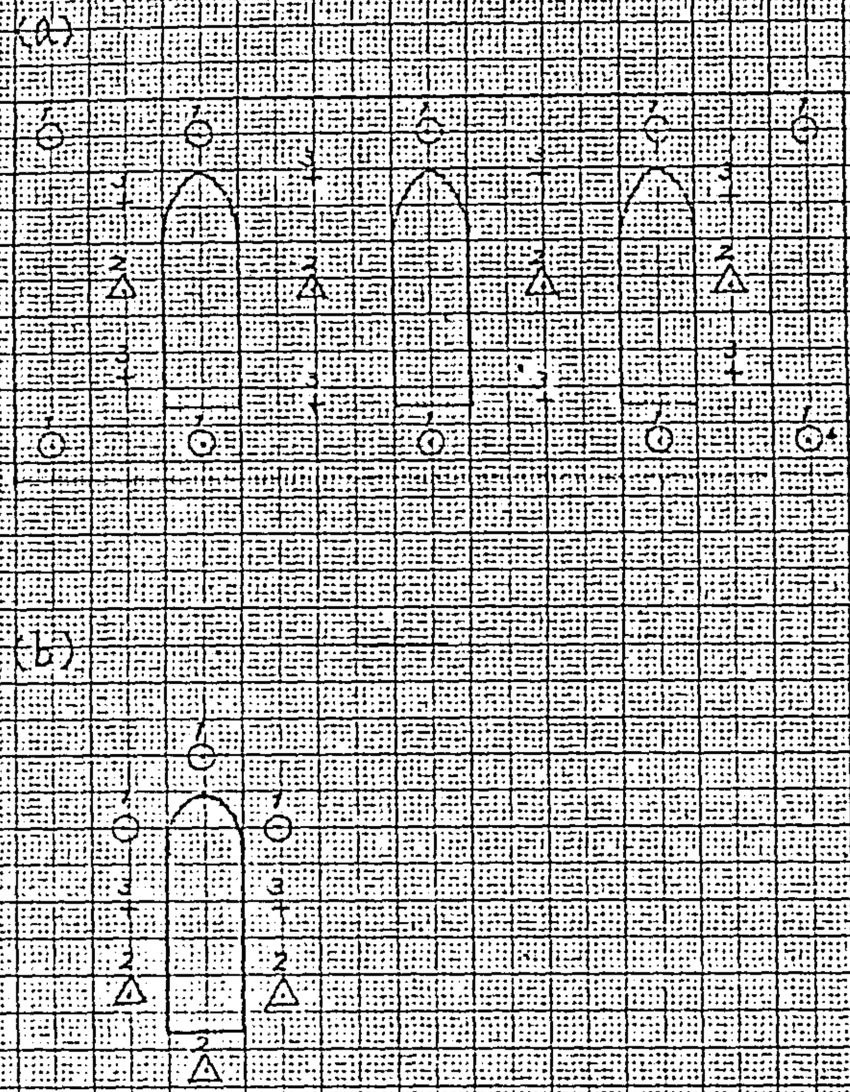


Fig. 7 Grouting



AGGREGATE SURVEY FOR TELUK LADA PROJECT

K. Uno
Nov. 17, 1977

Dispensing with the preliminaries:

1. Thank you for your kind help regarding to my survey in October. I guess you already received my interim report (Nov. 1)

2. At that time, I have written "Procedure of concrete aggregate survey" as in the accompanying sheets. But I am sorry to send you it too late, because of delay of typing.

3. It is thought inefficient to bring aggregate from long distance such as 50 km (Pasauran - Cilamer) or 60 km (Cihara - Ciliman). But as the total volume of concrete required for both weirs is only 10,000 m^3, it might not be so serious and needs not to search for new aggregate pit at considerable cost. This may be one opinion. How do you think about it ?

4. Based on the former view, I suggested and asked the survey of next stage to explore in the vicinity of each weir in the last letter. The supplemental explanations of the survey are as follows.

   a. The fundamental idea of procedure is that the sphere of exploration should be expanded gradually as is shown in attached map.

   b. The type of deposit is perhaps a river deposit or a terrace deposit (see page 7, 2.3). Please examine the existence of gravel - or sand stratum on river cliff (e.g. Serpong)

   c. In case of Cilamer weir, it might need to search a part of River Cikadum.

   d. In case of Ciliman weir, it is necessary to find out the nearest and suitable gradation deposit, furthermore the fine aggregate deposit if possible.

e. About the gradation of coarse aggregate (see page 9, 2. 8. 4)
About the gradation fine aggregate (see page 5, 1. 6), it needs to find out coarse sand (F.M 2. 3 - 3. 1)

f. In all case, we must have maps which we shall be able to lay down the distribution of deposits, even if it's not so perfect (see page 6, 2. 1)

g. At the prospect on geological map, what is expected as rocky coast are a part from Pasauran to Carita and a west part of Citeurep, and area lain between them may be sandy shore. It may be necessary to have the rough estimation about the quality of materials in these area (see page 7, 2. 3. d.)

5. When proper deposits are discovered, about the sampling (see page 8, 2. 7) and about the report (see page 9, 2.8)

6. A test standard which has a likeness to the method to identify the sand aggregate suggested by Mr. Hidayat last time is found out and added for reference in companying sheet.

7. If there is any question, please ask me, I wish I'll assist your job with pleasure. I regret not to send the photographs this time too.

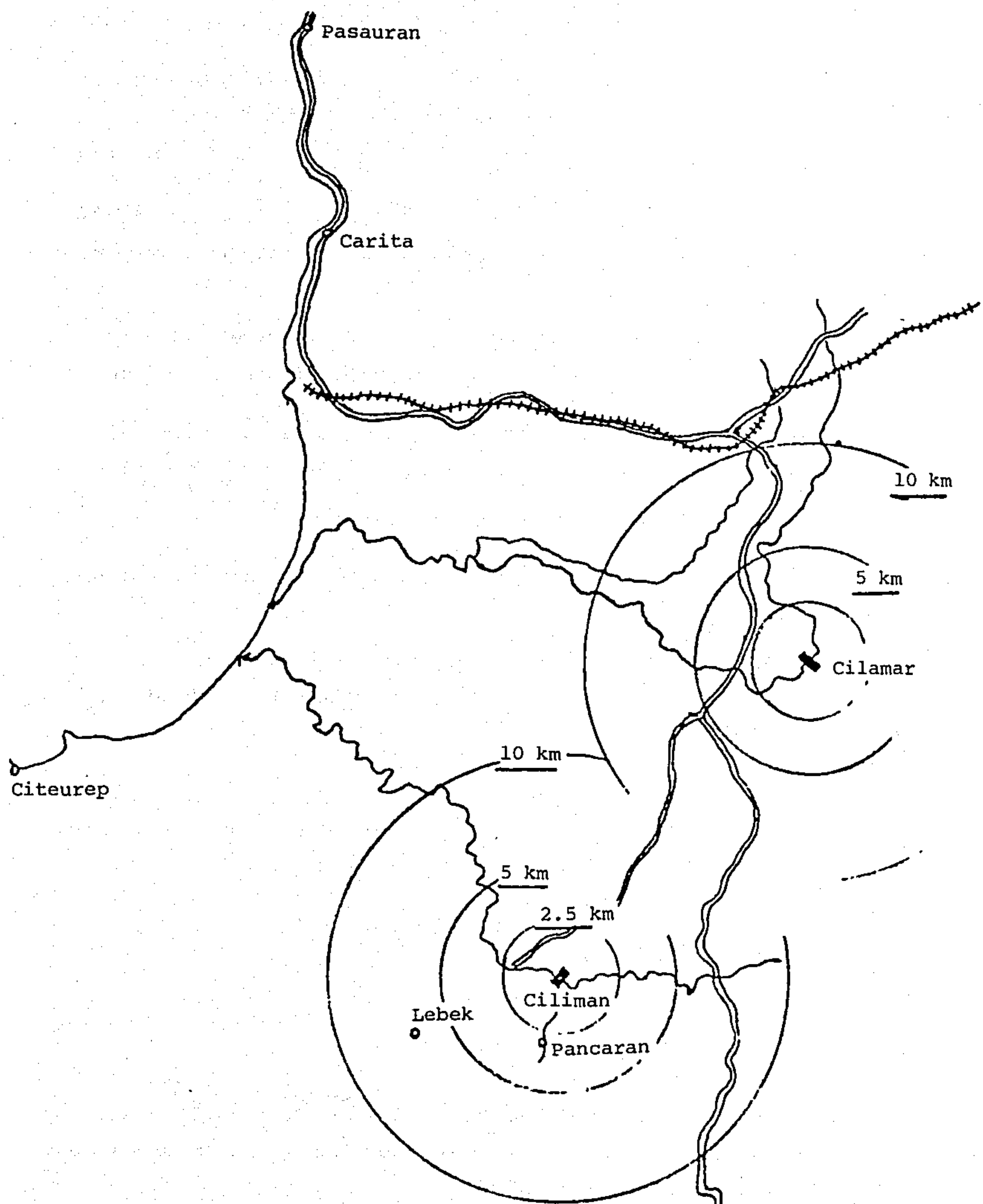
(United State, Bureau of Reclamation)

Concrete manual, Appendix Standard 15

Sedimentation test to measure of approximate volume of clay and silt in Sand.

The sand of 437.5 cc is put in a measuring cylinder of 1,000 cc and clear water is added to 875 cc degree. This mixture is shaken hard, then kept still for one hour. Just then, the sediment of 31 cc lain above the sand is nearly equal to 3% (weight).

If the result of test after washing treatment is good in the required quality, the sand will be approved to use. (The rest is omitted).


Pasauran
Carita
10 km
5 km
Cilamar
10 km
Citeurep
5 km
2.5 km
Ciliman
Lebek
Pancaran

AGGREGATE SURVEY FOR TELUK LADA PROJECT

K. Uno
Nov. 1, 1977

On Oct.30, I heard the calculation of construction cost was scheduled to do in the course of first week of November, then I write this temporary report in haste.

I can't decide the place of aggregate by the last survey. For our immediate need, I have nothing more to suggest the following assumption.

1. Fine aggregate pits which are said or supposed to fit concrete, are found at Cihara, Pasauran and Cisiment (Rangkasbitung's vicinity).

   They are almost same distant from construction site.

2. If make it rule to use natural aggregate, course aggregates are found at Cihara, Pasauran, and Cipana.

   They are seashore or river deposit. The river deposit near Panacaran (vicinity of Ciliman weir site) is in expectation but the details are not confirmed yet.

3. If use crush stone as aggregate, rock pits are found near Menes and Batubantar. They are at closer distance from the pits above mentioned. But in this case, it needs to compare the production cost.

4. Under these conditions, I propose to count the cost based on supposition that the aggregate is carried from Cihara or Pasauran.

These pits are very far from construction site, so I propose the field survey and sampling of next stage.

1. The detailed survey traversing the River Cilemer, looking for river deposit aggregate: Its range is extended for several kilometers up and down stream from proposed weir site.

2. The confirmation survey of River Panacaran (Tributary of Ciliman, near proposed weir site): The existence of course aggregate is already known

locally. This survey is expected to know the distribution, gradation and other properties and wished to find fine aggregate too.

3. In spite of these survey, I am afraid we fail to find fine aggregate. I think it's better to explore seashore sand between Labuhan and Panimbang.

4. If these survey come to nothing, we have to return the aforementioned plan.

EXTRACT FROM "LAPORAN PRA-RECONNAISSANCE SURVEY PROJECT IRIGASI BT. TABIR & BT. MERANGIN DI PROP. JAMBI, MAY 20, 1977"

Geology of Bantang Tabir, Batang Merangin Project areas

(1) Topography

Project areas (Soroko Kabupaten, Jambi Province) are situated at about 150 km from the west coast of Sumatra island and at 250 km from the east coast.

Expected irrigation areas are about 96,000 ha. each. Batang Tabir Project area is bound by the Tabir River and the Merangin River. Batang Meranging Project area is also bound by the Merangin River and the Tembesi River.

East boundary of areas are restricted by the Duabelas Mts.

West side of both areas are limited by the intake level of 70 - 100 m height. Their NW - SE direction is nearly 70 km long and NE - SE cross section attains almost 30 km width.

The lowest ground height in the areas is 20 - 35 m.

This depression area holds the direction of NW - SE, and is in parallel with the Barisan Mts. at west side and with Tertiary foreland (peneplain) with the Duabelas Mts. at east side.

The volcanoclastic materials originated in volcanism of the Barisan Mts. flowed out from east, buried the depression and formed a depositional surface.

This depositional surface streches to N where it contacts with low tertiary peneplain, and to E where it is ristricted by the Duabelas Mts, and to W where it attains to the foot of mountains of 300 - 500 m high, and to S where it extends to the foot of mountains of 500 - 1,000 m high. Besides this depositional plain extends further to east along the upstreams of the Merangin River and the Mesumai River.

This depositional surface has a tilt to the direction of NE, and it caused characteristic pattern of water system. The Tabir River runs to the NE and the Merangin River to the W and confluents to the Tembesi River. The water of Batang Merangin area almost runs in the Merangin

River and not in the Tembesi River. Regarding the water of Batang Merangin area, the one is drained into the Tabir River by the Mendelang River and the other drained into the Tembesi River by the Hitam River.

The depression which extends to the NW - SE direction through Sarolangun is in parallel with the direction of the Barisan Mts and the Duabelas Mts. and is thought to belong a geotectonic subsidence belt. Continuation to NW - ward is the depression of Mearabungo - Sungaidareh and this depression continues from Sarolangun via Surulangun to SW - ward further. These depressions are filled with volcanoclastic materials. In this depression, the lowest altitude is 20 - 35 m above sea, at the downstream of the Hitam and the Mendelang. Such configuration was probably affected by erosion and subsidence.

Anyway this stratum covers all the project areas and at someplaces the outcrop of underlaid Tertiary may be found. The age of this formation was described as Pleistocene but some one thought it might be Holocene.

Tertiary stratum

Stratum of Tertiary are distributed as a shape surrounding the deposition of volcanoclastic materials. These Tertiary stratum had been thickly sedimented in the east coastal plain of Sumatra. They are called as Palembang Formation. After that they were upheaved by anticlinal folding and grown once as a mountain range. Thereafter, being affected by erosion (peneplanation) they were formed to wavy hilly land of 50 - 100 m height. The Duabelas Mts. contiguous to project area on east side owe their existance to the more resistive granitic rock which intruded into Tertiary and Mesozoic stratum of core of the anticline.

There are Tertiary rocks abuted on Mesozoic or Palezoic strata in the valley of upper stream of the Tabir and the Merangin. They have possibility to be chosen as a weir foundation.

Mesozoic and Palcozoic stratum

Mesozoic and Paleozoic stratum which distributed in this district are distinguished into two geotectonic unite drawn a dividing line of WNW - ESE at Mt. Bukit Gedang situated on right bank going upstream of the Merangin Rivers, 25 km from Bangko.

The inclination of this depositional surface are almost as follows.

Ground height	150 m or above	1 : 250
"	50 m - 150 m	1 : 350
"	50 m or below	1 : 600

These figures are picked up on the map of 50 m contour line. The expected route of channel will be situated at 70 - 100 m height and at those height the topographical feature comes to gently rolling hills. Such condition can't be supposed from exting maps. As for the planning of farm lands, irrigation facilities etc., more detailed map should be prepared to know the shape, length, position of slope, the lief and the other topographic condition.

(2) Geology

Geological age, kind of rocks and their distribution in this district are shown by next table.

Age	Rock	Distribution
Holocene	(Alluvium deposit) sand, gravel	Present river bed and terrace
Pleistcene	(Volcanoclastic materials) ash, tuff	Project areas will be planned on this layer
Tertiary	(Upper layers) tuff (Middle layers) sandstone, shale (Lower layers) shale, sandstone	Project areas are surounded by these layer, volcanoc-lastic materials overlay on this layers in project area, they also outcrop on cliffs of up and middle stream of river.
Tertiary Mesozoic	Shale, limestone Shale, limestone, cheart	Ridge of the Duahelas Mts. at east side of project area, intruded by grantic
Mesozoic Paleozoic	Sandstone, conglomerate Tuff, breccia tuff conglomerate, sandstone, slate, limestone	East foot of the Barisan Mts. on west side of project areas, intruded by granite or quarty porphyry, contact with Tertiary, weir will be planned on these rock.

Geology of this district will be explained following the order on table.

Alluvium

These are river deposit of existing rivers, such as riverbed or river terrace. They are consisted of gravel and sand mainly and sometimes intercalated with clay. For the design of weir, their position, thickness and constituent materials etc. have to be took into consideration.

Volcanoclastic materials

They cover all the project areas. They form a gentle inclined plane from SW to NW. At some place, the section of layers of 5 - 6 m thickness shows red volcanic ash and white tuff, intercalated by chart rich gravel layer.

These huge volcanic eruptive materials were transported from volcanoes of central the Barisan Mts. and deposited in the depression of that time. They extenend from the district of upstream of the Merangin River to the lowplain of the Hari river. Its depositional plane is considered to be continuous, but being dissected in accordance with ground height, the plane turned to the configuration of plateau, hill, terrace or wet land.

On the SW side of this line, slate, sand stone, chart, limestone and volcanic rocks compose high mountain ridges of Barisan. On the NE side, there are low mountains consisted of Mesozoic, Paleozoic, granite and other intrusive rocks.

These hard rocks outcrop on the cliff of river of the Tabir and the Merangin. Near the estimated weir sites, these rocks contact with Tertiary rocks but their boundary can't be found out in present survey. However, the both rocks are not considered to have sever defects as the foundation of weir.

(3) Relation of soils to geology and topography

The rough distribution of soils may be estimated from the geology as parent material and the topography as the factor of circumstance. Soils of this district are shown in next table.

Area	Altitude	Parent material	Soil
(Within project area)	50 m or below	Volcaniclastic material	Organozols
	50 - 100 m	"	Latozols
(Out of project area) Upstream of the Merangin	150 or above	"	Andozols
Plannation of Tertiary	50 - 100 m	Tertiary	Red-yellow podosolic soils
Mountainous	200 or above	Complex	Complex soils

The characteristic of soils are explained in brief as follows.

Organozols

Surface layer is comparatively thick, humus and black soil, lower layer consists of mineral materials affected by gleization. They are almost acidic or neutral and developed at ill drain area.

Latezols

Soil color is red or brown. Differentiation of soil layer is not clear due to sever weathering and eluviation. Content of humus is little, under nourishing and acidic, fragile clayey soil. Physical properties are good and resistible to erosion.

Andozols

Surface layer is black or dark brown and lower layer is brown or yellow brown. Humus is rich but nutritive substances are rather little. Percoration of water is good but resistance for erosion becomes weak in case of bare land.

Red-yellow podosolic soils

Being affected by intense eluviation, surface layer is light grey or yellow and lower layer is red or yellow. Soil is often mixed with parent materials. By differentiation of soil layer, percolation is not enough. Humus and nutrition are poor, acidic.

Mountain complex soils

Thickness of soil layer is thin. Many rock fragments are often included. Speciality of soil is determined by its parent material.

(4) Geological view about the foundation of construction

(a) Weir site of the Tabir river

The plan of 20,000 ha. irrigation area was made in Dutch age and part of plan can be seen at Jambi. From a plane of weir site among them, we can estimate its location and scale etc. Its intake level was about 70 m, therefore we could easily examine the neighbourhood of weir site at old time and consider of other alternatives.

Near here, there are the river terrace of about 3 m hight and the rather high river cliff consisted of baserock. The river terrace consists of, from top downward, soil, sand and gravel (1 - 2 m). The depth of base rock underlain is 2 - 5m. Then, in case of coupure method, weir site can be selected to fix the weir on base rock (probably impervious, sufficiently bearable) and to reduce the excavation cost.

For other design, it is not so difficult to construct the weir. It will be effective to ready the simple electrical exploration for geology to compare the alternatives. The selection of channel route may not be difficult too.

(b) Weir site of the Merangin river

This proposed site is not clear on the topographic map of 1 : 100,000 scale but it is supposed that the intake level of about 70 m was intended. The river terrace (about 3 m and 6 m) and river cliff (about 20 m, base rock) are developed, and the conditions are not so different from the Tabir weir site.

The site must be decided on relation to channel route and if it is either open cut or tunnel, it shall be judged on a detailed map. Anyway in advance to the decision, geological survey shall be required. Regarding open cut, the channel route will almost run along the weak volcaniclastic material layer, therefore it may be effective on design to use the soil mechanic data of the Sumatra high way.

EXTRACT FROM "STUDY REPORT ON JAMBU AYE IRRIGATION PROJECT, OCTOBER 1976"

1. Summary

(1) The project is located in the Jambu Aye deltaic plain, which is situated at the east coast of Aceh Special Province, Sumatra, about 250 km to the east of Banda Aceh city.

The total gross area is 26,800 ha. and the potential area for irrigation is 21,500 ha. The total population is estimated as 102,000.

(2) The river of Kr. Jambu Aye, having a catchment area of 4,400 km^2, runs northward through the deltaic plain and forms a Diamond Punt. The downstream part of the river has already died and is called Kr. Jambu Aye Lama (old).

Now, the river of Kr. Arakundo, where the flood Control Project is being carried out by Directorate of River, runs eastwards from the center of the project area serving as the downstream part of Kr. Jambu Aye.

(3) The climate is tropical with mean annual temperature of about 26°C and average annual rainfall of 1,500 mm.

Generally, the wet season is from September to January and the dry season from February to August.

(4) There is no irrigation systems available for some 15,000 ha of the present paddy fields. The rice culture depends on rainfall only in wet season.

Although there old existing irrigation facilities composed of a free intake and some canals constructed in Dutch period, they have never been used since the free intake was damaged with flood and the construction of Canals was stopped halfway due to World War II.

Also, the rice culture on some depressed is often damaged with inundation or salt injury for lack of adequate drainage facilities.

(5) Since abundant water resources can be expected from Jambu Aye river even in dry season, this project aims to facilities double cropping of rice culture to the whole area providing with proper irrigation and drainage facilities.

The scope of project includes,

- Construction of a diversion weir at Jambu Aye river
- Construction of primary and secondary canals for irrigation
- Construction of a tidal sluice at Piadah river to improve drainage and to protect salt injury
- Improvement of small rivers and construction of a drainage canal.

(6) The total construction cost is estimated at approximately Rp. 5,400 million.

The incremental production is assumed to amount to some 198 thousand tons in dry unhulled rice per annum.

The project will be regarded as efficient enough and contribute largely toward the development of the region.

4. The project area

4.1 Location and general feature

4.1.1 Geographical location, road system

The project area is located in the Jambu Aye deltaic plain, which is situated on the east coast of Aceh province, Sumatra. Panton Labu which lies in the center of this plain is located at 5°07' northern latitude and 92° 28 eastern longitude.

Its coast line shows a typical triangle shape so it is easy to look for the project area even on a small scale map.

It is boardered on the south by hilly areas and limited on the north by a tidal compartment. This area including valley bottom lowland of the Jambu Aye river extends about 33 km from south to north and about 27 km from east to west and its elevation is less than 20 m in height.

The state road goes northward from Lhoksukon at first and traverses eastward in the centerpart of the area and goes across the Arakundo river at Arakundo. This route is almost parallel to the route of railway.

The Kabupaten roads mainly branches from the state road to north or to south. Only the state road is paved with asphalt, but weak foundations prevail in the whole area and the road is considerably damaged by heavy traffics. Now their repair or improvements are being executed.

The possible roads by jeeps are between:

1. Samponit - Tjotolaba
2. Keude Simpang Penet - Kuala Lagobatang - Uleerubeptimo - Payadua - Rambong datan
3. Keude Simpang Penet - Matangreudeueb
4. Panton Labu - Meuna Sahmeur beuber
5. Panton Labu - Lenqkahan
6. Tanjong mindjai - Matang guru
7. Simpang Ulim - Pajadjambe
8. Simpang Ulim - Lhoknibong - Aluemirah

Including another short roads, there are many damaged bridges and roads surfaces area poor especially in the rainy season.

4.2 Natural conditions

4.2.1 Topography

The valley bottom lowland of the Jambu Aye river has a width of 7 km at the branched point of the Arakundo river. From there the Jambu Aye river runs northward through the deltaic plain and forms Diamond Punt. But this old river has already died and now the Arakundo river is the main stream of the Jambu Aye river.

The ground height and river bottom height near the proposed weir site have an elevation of about 20 m and 10 m.

The gradient of the ground surface is nearly 5 : 10,000 on the valley bottom lowland and 4 : 10,000 on the deltaic plain.

The route of river are considerable meander accompanied with natural levees, abandoned channel (oxbow lakes) and wide back swamp areas. From such topographic relices of old meandering rivers and their land use point of view it can be supposed that there were many meandering rivers branched from the Jambu Aye river and flow to the Strait of Malaka, but their routes or their old and new are not easy to be recognized.

Bordering on the old Jambu Aye river we can see topographic differences. On hilly area of southern part, erosion on hills is more advanced on west side than that on east side.

On northern foot of these hills forms a wide low swampy area on west side and Arakundo river on east side.

The sea coast line is simple and there are many bars paralleled to the coast line on west side but the coast line is rather complex and there are many spits and wide estuary on the east side. The land use or location of settlements seem to be influenced by these topographic differences and it seems to be suffering from a stronger tidal effect on east coast.

As to the occurrence of these differences, it is not clear that it was resulted from whether littoral current or movement of earth crust or the others.

According to the hearing, a tidal flat with a few km width extends on the western area and daily difference of the water level amounts to about 1 - 1.5 m in the river near the state road.

4.2.3 Geology and soil

(a) Geology

In catchment area, the pretartiary, tertiary formations and quaternary volcanic rocks are distributed. Southern hilly areas (20-150 m in height) consists of diluvial terrace deposits.

Pretertiary formations include limestone, sand stone, shale, schist, etc. and tertiary formations contain breccia, sand stone shale, limestone, marl, lignite, etc.

Dilluvial terrace deposits come from the old river deposit and consists of layers graded from boulder to plastic clay. Alluvial deposits mainly consists of clay, silt and sand. In general, the grain size of deposit is the largest in river bottom deposit, followed by natural levee deposit and the finest in deposit at back swamp area.

According to the data of soil tests of bridge foundation between Lhoksukon and Panton Labu, silt and clay layers have a value of uniaxial compression test (qu) of less than 0.6 so they belong to weak stratum. These layers somewhre continue to a depth of more than 30 m containing humus material. Sand layers with a few meters of thickness are sometimes intercalated among such a weak stratum and serve as a bearing layer.

(b) Soil

In the project area, the recent fine textured alluvial soil previal. Rice fields are almost located at interlevee lowland, and almost same in their agricultural characteristics. Result of soil test for soil samples collected in the area show that the soil proved to be silty clay in view of grain size, and to be CH (Cohesive soil having high liquid limit) according to the unified soil classification. And permeability of the soil is supposed to be almost 10^{-7} cm/sec order.

Some parts of the area are affected by inundation of tide, but these problems may be solved by means of providing adequate drainage systems.

Soil test results are shown in Appendix.

5.3 Proposed civil works construction

5.3.1 Diversion weir

The proposed weir site located about 35 km upstream of turning point from Kr. Jambu Aye to Kr. Arakundo is suitable to construct a coupure weir from the topographical point of view.

The present design by P.T. Karpa shall be esteemed and no alternative regarding to location and main design values will be required, because some modification of the intake facilities will be necessary according to the alteration of diversion requirement including the additional right bank intake, due to the expansion of the project area.

The main features are as follows.

Catchment area	4,179	km^2
Design flood	3,000	m^3/sec
Design minimum discharge		
in August	38.4	m^3/sec
in May	136.0	"
Diversion requirement (Maximum in May)		
Left bank	38.15	"
Right bank	4.15	"
Weir length	100	m
Weir crest elevation	EL + 16.40	m
River bed elevation	EL + 13.15	m

The right bank intake will be dealt with setting pipes inside the weir body. In this project, only a pipe or two pipes will be enough for some 2,000 ha. of the right bank area.

However, it is desirable to set some spare pipes in advance because there is some more posibility of future development of the hilly land at the right bank area.

From a geological point of view, the proposed weir site and surounding areas, consist of alluvial deposits such a clay, silt and sand. On opposite side of river the hills consist of deluvial deposits such as andesites, andesitesboulder, gravel, sand, tuff, silt and clay layers.

The layers under the short cut are, downward from the surface, silty clay of 4 - 9 m in thickness, fine-medium sand of 3 - 4 m in thickness and farther lower position is coarse sand expected to be with pebbles.

These silty clays are classified to CH,CL, MH, ML according to unified classification. And qc values by dutch corn penetration test are lower than 10 kg/cm^2 and their permeability test prove its permeability to be 10^{-7} cm/sec order.

Fine medium sands are classified to SP and qc are more than 60 km/cm^2. They have a permeability of 10^{-3} - $^{-4}$ cm/sec order.

Judging from the facts stated above the weir site is deemed to have no problems from an engineering geological point of view.

The soils which are examined for a coffer dam are identified as sity clay cohesions of 0.5 - 0.7 kg/cm^2, angles of friction of 10 - 25° after a triaxial compression test.

These data may be used not only for banking but also for excavation of channel.

PROCEDURE OF GEOLOGICAL SURVEY OF PUMP STATION AND CHANNEL
FOR SITUNG IRRIGATION AREA, WEST SUMATRA

K. Uno
Sep. 5, 1976

1. The site was decided at the middle between Kotatua and Situng (about 14 km down stream from High way bridge at Sungai Dareh), then the very site will be sellected near cliff at the most bent or its little down-stream part, because near here may expose the hard rock and may be the deepest water depth.

2. The geological condition is not known yet, but we may assume the following section from the instance of Situng.

Reddish brown soil	5 m
Tuff	5 m
Gravel	3 m (above water level)

It's only a assumption, but we have to plan the arrangement of pump station from topographic map and assumed geological data on the desk now. This is concerened to pump, engine, generator, discharge tank and channel. It needs irrigation requirement, head, suction level and kind, number and capacity of pump. Then we can assume the space, elevation and excavation being required.

3. After that, detail geological survey have to be done at least with in the range of diameter 1 km or so, and be made outcrop map and assumed geological section based on topographic map of 1 : 5,000. It will take half day on boat and half day on foot.

4. Based on that result, we shall recheck the arrangement of pump station. In this time, we need to know the required bearing capacity of foundation and its safty factor usually used for pump or generator station for house, pump, motor, engine and axial load or earthquake pressure etc.

5. After above decision, number and depth of borings are to be planned, 1 - 2 borings need to reach river bottom level, and Standard penetration test for each kind of rocks is suitable to assume the bearing capacity but shearing test with undisturbed sample will be needed for soil.

6. Besides, it will be required to make the sounding of river, and to record the present situation of river within proper range for future maintenance.

7. As to the geological survey of channel, the elevation of bottom of channel at each place has to be fixed at first and then the route of channel has to be examined about what kind of rock or soil occur above and below on that elevation, from the observation of outcrop, sometimes by mean of digging. It will take a lot of time, but without these consideration we can't find the proper test method to assure the factors of stability of slope and permeability of channel.

THE GEOLOGICAL VIEW OF THE ALTERNATIVES OF THE PUMP STATION AND FREE INTAKE OF SUNGAI DAREH PROJECT, WEST SUMATRA

K. Uno

Aug. 25, 1976

This report will be submitted as the results of survey from 18 to 24, August, 1976. The main purposes of this survey are:

1. To select the best location among 4 proposed sits as the pump station for the Situng irrigation area (about 2,000 ha)
2. To compare the pumping site with the natural inflow site on their advantage for whole irrigation area (about 41,000 ha)

Outline of conclusions of survey are as follows:

1.1 a. Four proposed sites, which are located at about 2.5 km (first bent of Batang Hari), about 8 km (near Siguntur), about 14 km (near the elevation mark of 97 m) and about 18 km (near Situng) downstream from the High way bridge, have almost same geological condition so far as I could see.

b. All those bent sites of river are consisted of comparatively (medium) hard rock.

And it's a reason why the river chages its flow direction at these bents (so far as this section is concerned).

c. These rocks belong to the Tertiary Formation i.e. clay stone, sand-stone, tuff and conglomerate etc. And conglomerate or sand stone is exposed at the water edge. In case of Siguntur, granits are exposed (hard plutonic rock, but their continuities are not known) and are covered with the Tertiary conglomerate.

d. Thus, the selection is not necessary to be thought in geological aspect but on distance to benefited area, and site of Situng is considered to be the most suitable as intake for pumping.

1.2 a. Outcrope (cliff) near the site of Situng is cosisted as follows.

Reddish brown soil	(thickness	about	5 m)
Sandy tuff	(	"	3 m)
Conglomerate	(	"	3 m above water surface)

These layers are changeable on rock facies, thickness and elevation with places. Though it may need some treatment or protection of foundation, severe difficulty will not occur as the base of pump station.

b. Presumption about the shift of the gut near by in future is not easy because of existence of sandbars at up and down stream or confluence of Sungai Kuta at down stream etc., but at this moment, there may be no way except that we assume the stabilization from the fact that difference between 1943's map and present one is hardly found out.

1.3 As the surface of plain is covered with thick reddish brown soil of more than 5 m (origined from volcanic ash, silt or clay, soft), it needs to examine the share strength and the permeability for channel design.

2.1 a. Proposed site of pump station for whole area near Sungai Dareh is considered to be based on Tertiary conglomerate and the conglomerate is covered with recent terrace gravel, so the characteristis as the base of pump station are hardly different from the case of Situng.

b. On proposed free intake site which is placed at up stream of about 14 km from the High way bridge, the river bed and both side are formed with unidentified green hard rock. Though necessary to be tunnel intake, it is considered to be suitable for free intake.

2.2 Though it is only in my opinion, if some difficulties caused by its topography or geology occur to construct the channel, free intake may be the better way as to the management or the imposition of farmers in such vast irrigation land.

2.3 There are no topographic and geologic data refered to channel route yet, but its survey seems not so difficult excepting its long distance.

TRENDS IN GEOLOGICAL SURVEY FOR FILL DAM

I have not so much experience yet about geological condition of dams in Indonesia. So I intend here to write a story about trends in geological survey for fill dam in Japan. It's concerned with the fact that the base rock of dams has become more complex and methods of survey must be suited to their multifarious foundations.

I. Present situation of fill dam for irrigation

It is said that there are irrigation dams of 280 thousand and more in Japan. Number of dams that have been constructed or are in planning now is shown in Table 1. These statistics were collected in 1973 and are limited to fill dams within the jurisdiction of Ministry of Agriculture and Forestry.

Table 1. Fill dams for irrigation now in progress (Total 239)

	Number	%
Dams under construction	161	67
National enterprise	68	28
Prefectural enterprise	93	39
Dams under planning	78	33
National enterprise	50	21
Prefectural enterprise	28	12
Dam height (m)		
15 - 40	160	67
40 - 60	66	28
60 -	13	5
Effective capacity (million m^3)		
- 3	143	59
3 - 10	71	30
10 -	25	11

Prefecture is an administrative unit and has almost same area as a Kabupaten. Difference between national and prefectural work is distinguished by kind of works and benefited area.

Among these dams of 239, dams of 81% are mainly aimed for irrigation and 19% are for flood control.

For reference, types of irrigation dams excepting ones of planning are shown Table 2.

Table 2 Types of irrigation dam

Dam type	Number	%	
Fill dam	138	83	85
Combination dam (Fill/gravity)	3	2	
Gravity dam	24	14	
Arch dam	2	1	
Sum	167	100	

Among these dam types, the fill type is the overwhelming majority. Though there are some social or economic reasons, one important factor to bring about this tendency is that suitable sites for concrete dams have already been used and quality of base rocks have been worsening for concrete dam. New damsites are apt to be restricted to geologically young or volcanic area in Japan. This situation is alike to Jawa, for reason that the land mainly consists of young and volcanic elements and it is therefore inevitable to make fill type dam for most sites. It does not necessarily depend on the high cost of cement construction.

II. Some geological problems at fill dams

The geological problems at fill dams totalized in Table 1 are classified as shown in Table 3.

Table 3 Geological problems at fill dams for irrigation

	Number	%
1. Base of dam body	239	100
Ones having some problem	88	37
Thick talus	1	0
Thick alluvium	7	3
Thick diluvium	6	3
Thick masa (a)	10	4
Lava	36	15
Volcanic ash and lapilli	2	1
Shirasu (b)	14	6
Welded tuff	12	5
The others	151	63
Segimentary rock	102	43
Igneous rock	38	16
Metamorphic rock	11	4
2. Spillway requiring special examination	48	20
Bearing capacity	28	12
Failure or slide	20	8
3. Reservoir basin requiring special examination	56	23
Leakage	45	18
Failure or slide	21(9)(c)	9(4)

Note: (a) Masa: Sand derived from weathered granite
(b) Shirasu: Volcanic silty sand
(c) is shown the number overlapping on leakage

1) Base of dam body

In Table 3 "The others" means common base rock of dam up to this time such as sand stone, shale, granite, diorite, other igneous rock excepting volcanic rock, crystalline schist or gneiss etc., for these rocks, the foundation treatment were usually cut off by core trench, concrete replacement for fault zone or cement grout for pervious layer. Among the total of 239 sites, 88 sites (37%) having special problems, almost all belong to young stratum or volcanic origin deposit.
This value may be the evidence of trend to worsening in geological condition of damsite.

In case of talus, alluvium or Masa, if the depth to base rock is shallow, it's enough to exclude the underpart of core.
If not, must be taken some measure for leakage or differential settlement. Generally speaking, settlement of base of fill dam is smaller than consolidation of dam body, therefore usually there's no problem. But in case of concrete cut-off wall connected with asphalt facing, sharp change of base slope or uneven distribution of poor ground, precaution must be taken to prevent cracks on dambody. (see Figure 1, 2)

In case of lava or welded tuff, the bearing capacity may be enough but sometimes they have many cracks in themselves and confined aquifer underlie them, therefore treatment for leakage is often required. Counter measure may need much money for leakage control in shirasu or volcanic ash and lapilli, and such rocks also need the examination for piping and liquefication in saturated condition. (see Figure 2, 3)

In areas composed of such deposits of volcanic origin, dams which were higher than 5 m were not constructed until recently but the increased water demand has required construction of reservoirs even in such area with adverse geologic condition. So far, the cost of foundation treatment hardly exceeds 10% of dam construction cost but the situation is changing now.

As another recent tendency, dam sites consisted of strata which belong to much different geological age often occur. In these cases, weak layers such as old soil, weathering zone or sand and gravel is often sandwiched between older and younger stratum and causes trouble needing treatment. (see Figure 2, 4)

2) Geology of spillway

It is said that spillway must be constructed on hard base rock principally, but nowadays it is becoming difficult to follow this rule.

There were already some instances where spillway were constructed on loose sand (Masa), diluvium, sand and gravel or volcanic silty sand (Shirasu). In these case, it is necessary to apply design methods to protect against differential settlement, uplift or piping etc.
Concerning spillways, the sites that required detail investigation reach to 48 sites (20%).

A spillway is often constructed after cutting a steep slopes and failure or slide sometimes occur. The causes of failure are sometimes due to the material itself such as shale or clay, or come from their geological structure or joint system. When such failure occur in the course of construction, it only increases construction costs, but if after completion, it may bring much damage to lives and properties. (see Figure 5)

3) Geological condition of reservoir basin

There were not so many cases that have previously been a problem, but increase in demand for dams in volcanic areas make it necessary to examine leakage and failure in reservoir basin.

In case materials of basin have permeability of 10^{-3} - 10^{-4} cm/sec. order, such as volcanic silty sand (Shirasu), welded tuff, lava volcanic ash and lapilli and so on. Analysis on amount of leakage must be considered.

In case materials of basin are apt to suffer erosion by surface water or wave like volcanic silty sand (Shirasu), sand (Masa), thick loam or tertiary shale, slope failure must be studied carefully.
For a certain dam being planned now, the cost of protection against

failure is estimated 2 billion Yen against the dam body cost of 500 billion Yen. (See Figure 6)
Reservoir basins that need investigation for leakage are 45, and ones for failure are 21 (including 9 which are overlapped with ones for leakage), and both make 23%.

III. Stage and their aim of survey

Geological survey may be divided into four stages running parallel with operation of other scheme. It is necessary to have correct understanding about subject of survey in each stage.

(1) Reconnaissance stage (stage of mapping out a scheme)

Up to now, site of a bad geological condition can be kept out from consideration in reconnaissance stage and the main elements of selection are determined by capacity and efficiency of reservoir. Main works are studies of existing data and surface survey. But now, sometimesboring or leakage analysis is necessary even in this stage because geological condition of area may be poor.

(2) Planning stage

In this stage, dam center line, dam type and its structure must be decided and the deviation of estimated construction cost must be kept in the range of $\pm$10% of the actual one.

(3) Detail design stage

Supplementary borings for decision as to final standard section of dam body, spillway design or foundation treatment should be completed in this stage. Another survey such as test of embankment, blasting test of rock or grouting test are main works in this stage.

(4) Construction stage

In this stage where the dam is under ocnstruciton, new, unexpected troubles often occur and require new investigations but fundamental issues concerning dam design must be solved in preceding stage. Additional works in this stage are detail survey for purchase of borrow pit, recording of geological condition in each construction step to leave informations for future, geological mapping and arrangement of grouting records for official inspection of foundation etc.

IV. Method of survey

This brief discussion is not intended to give complete explanations of all kinds of methods. Major items of recent importance are described here briefly.

(1) Geological mapping

For this work, the most important point it should be done by reliable man who has a knowledge of both geology and dam design.

Three kinds of geological maps are usually used i.e. (1) Wide area map (scale 1 : 25,000 - 50,000), (2) Environment map (scale about 1 : 5,000) and (3) Damsite map (scale 1 : 500).

A wide area map is drawn from studies of field outcrop, aerialphotos or exisitng data and express the distribution of favourable and un-favourable strata for construction, and is used for selection of damsite and calculation of sedimentation etc. Help by the staff of university is often useful to get knowledge of stratigraphy and geological structure of area.

Map of environment of reservoir is used for finding dam center or borrow pit, and to estimate the posibility of failure or leakage. Classification of rock facies should be done from engineering aspect without adherence to existing data, it must include distribution and depth of talus, terrace and river deposit, and must project the assumed geological section along important lines, and location of confirmed out erop and its columnar section. Mapping of damsite is same as hitherto.

(2) Analysis of leakage

Leakage may result in a decrease of reserved water and a disaster of piping. It needs a survey including neighbouring valleys about location of groundwater, spring, permeable layer and permeability by geophysical exploration and boring.

Amount of leakage has been tried to calculate by electric hydroulic model method or numerical model (similation by computer).

(3) Piping and liquefication test

Piping flow in dam body is usually protected by using filters. As for piping occured through natural ground, allowable groundwater gradient is to be sought from critical hydraulic gradient of strata. As piping and liquefication are liable to take place in earthquake, both have been studyed by soil mechanic vibration test and the results have been accumulating.

(4) Grouting test

Triple point method is commonly applied, but in case of rocks which have many cracks it needs to test for grouting of 3 or 5 rows for check ineffective spreading of grout milk. As for chemical grouting, life of chemical gel should be ascertained too.

(5) Permeability test

In case of boring without water to get good core, often a thin film is formed on internal surface of hole which decreases the permeability value by one order or more, therefore ocasionally permeability tests need to be sacrificed to get good core.

Use of bentonite to keep hole wall well should be restricted as far as possible.

Generally speaking, permeability test by boring hole is apt to show low value, and apparent permeability got by charge (pressure) method is smaller than one by discharge method.
For rocks which have vertical joints as welded tuff, permeability got by vertical boring will occasionally appear low, therefore oblique boring is more effective in that case.

(6) Bearing capacity test

Plate loading test is commonly used to get bearing capacity but it needs to be done in lateral pit. In-hole horizontal loading test is executed in boring hole recently and get ultimate or allowable bearing capacity from the relation of pressure and deformation.

(7) Survey of dam body material

This survey requires decisions as to: location, strata, proved soil reserve and quality test. This survey is the most important one to decide the type of dam. At begining stage, sampling should be done in extensive area and it's enough to be given rough character of material. And then it should be advanced to test for determination of design value.

Recently, soil including coarse grains (ø > 4.75 mm) or soft rock have often come to be used.

For the former, compaction and dynamic test have been executed with large mold such as triaxial shear test equipment having mold of ø = 1,200 mm.

For the latter it needs the examination of alteration for worse in long time.

Explanation of figures

Fig. 1 Thick river deposit (sand and gravel) of 30 - 40 m, and length of crest will be more than 500 m, it was a serious problem how to cut off the leakage flowed through such vast section. Cut off wall had been studying about various method such as I.C.O.S method, E.L.S.E. method, asphalt wall method and well point method, etc.

Fig. 2 Old river deposit is found between sandstone, shale (mesozoic) and welded tuff (dilluvium). Upper welded tuff has many cracks. As the lowest part of this rock (thickness of 1 - 2 m) is claycy, settlement of this layer was expected. In case of such site, old river deposit often has a confined ground water.

Fig. 3 Both side of valley are occupied by Shirasu (volcanic silty sand). As for this rock there is the possibility of leakage, piping or liquefication.

Fig. 4 Basalt (diluvium) is laid on granite (mesozoic ?). Both are hard rock by nature but the upper part of granite was weathered and eroded partly and was deposited on it by clay and sand, before the lava of basalt was flowed over all. The sand-wiched layers are weak and pervious.

Fig. 5 After the cutting for spillway and road, cutting slope composed of welded tuff, begun the slide on large scale. Welded tuff itself had not character of sliding but there was black clay layer only several cm and it acted as lubricant and could not be reserved water.

Fig. 6 Almost all slope of Shirasu (volcanic silty sand) are suffered by failure. Maximum height of failure is about 25 m, their lengths are sumed up to about 2.5 km, their total volume calculated about 400 thousand m^3 and it is estimated to increase the volume by 50% in water. As the distribution of Shirasu around this basin is not so extensive and failures have not affected so much on water volume of reservoir in this case.

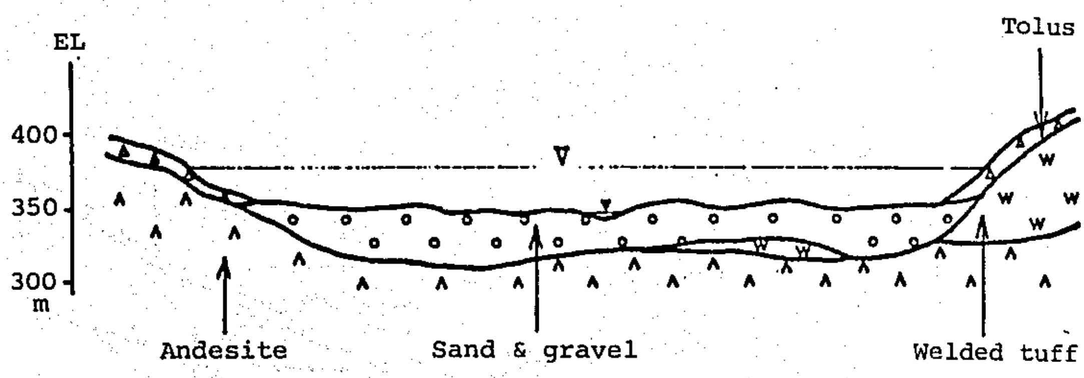


Fig. 1 Chubetsu Dam

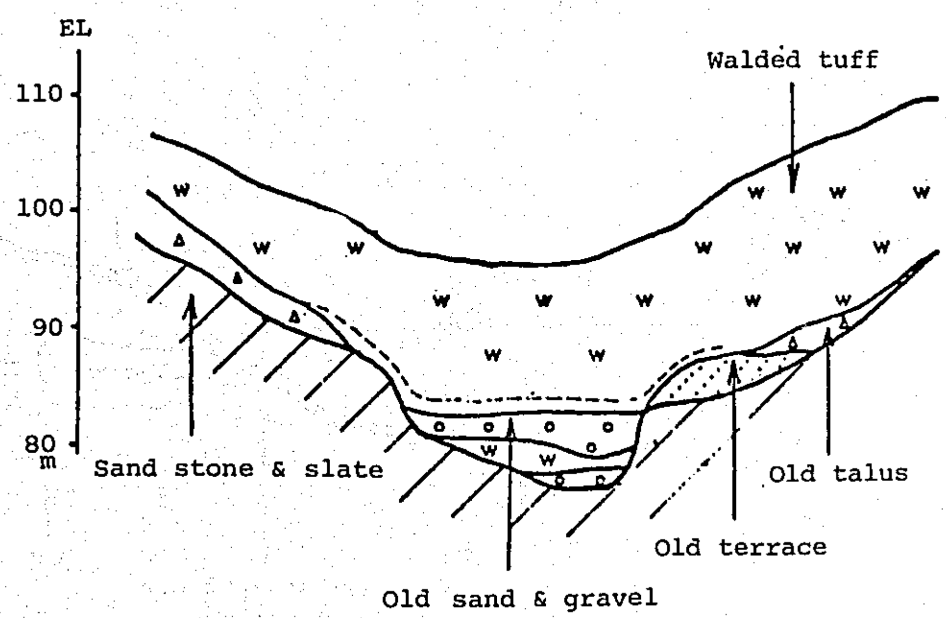


Fig. 2 Nagayoshi Dam

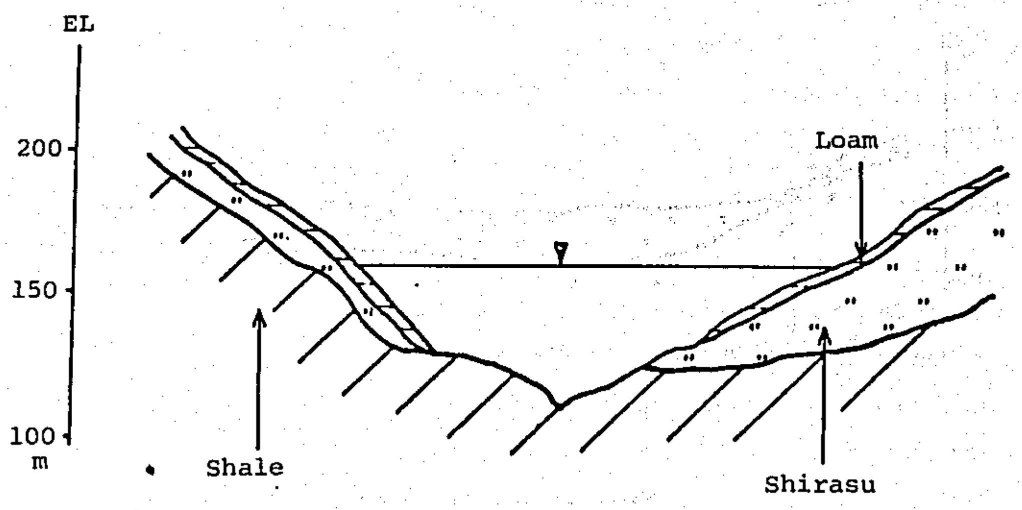


Fig. 3 Namioka Dam

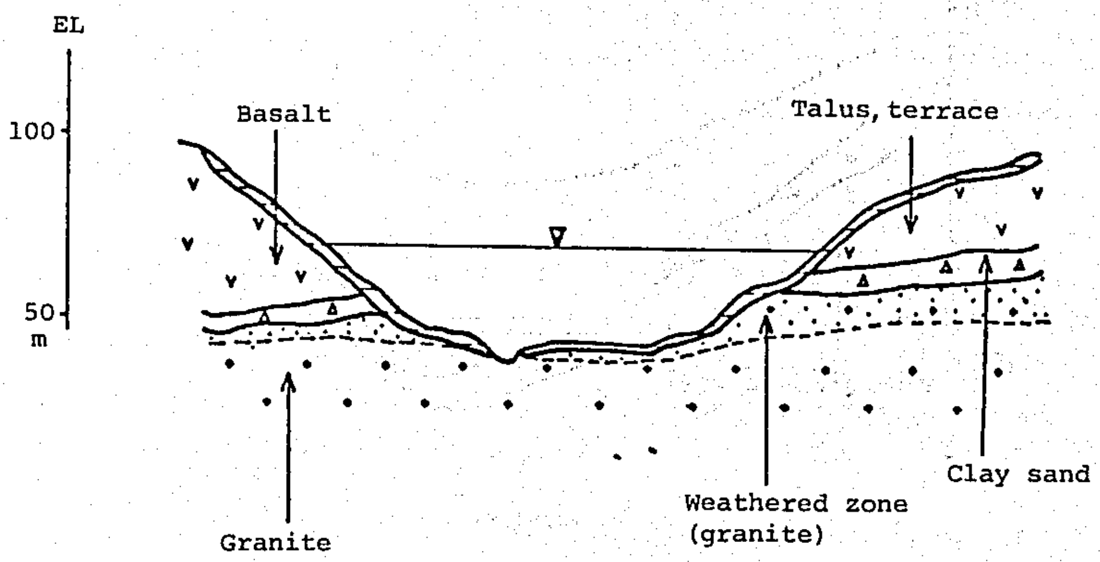


Fig. 4 Uchiage Dam

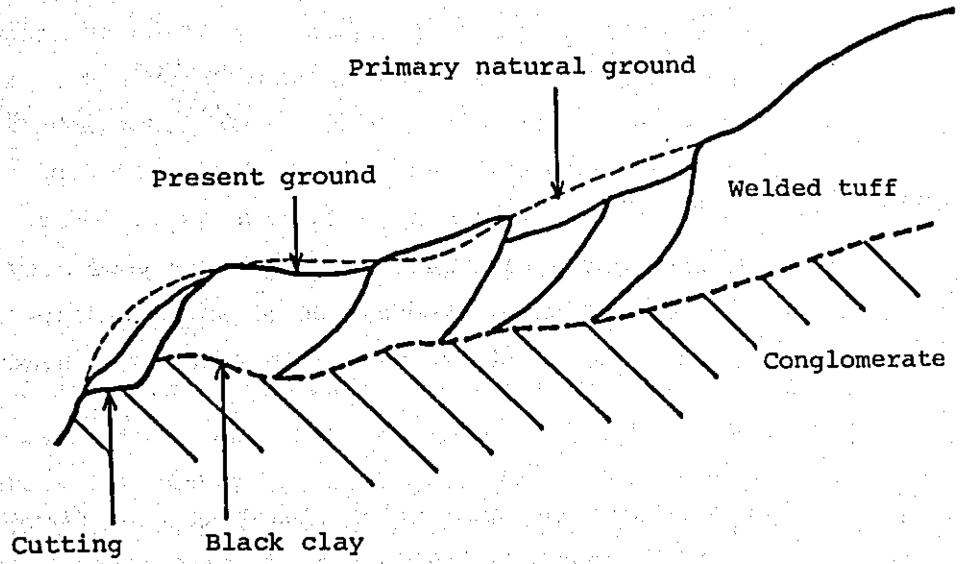


Fig. 5 Shidabaru Dam

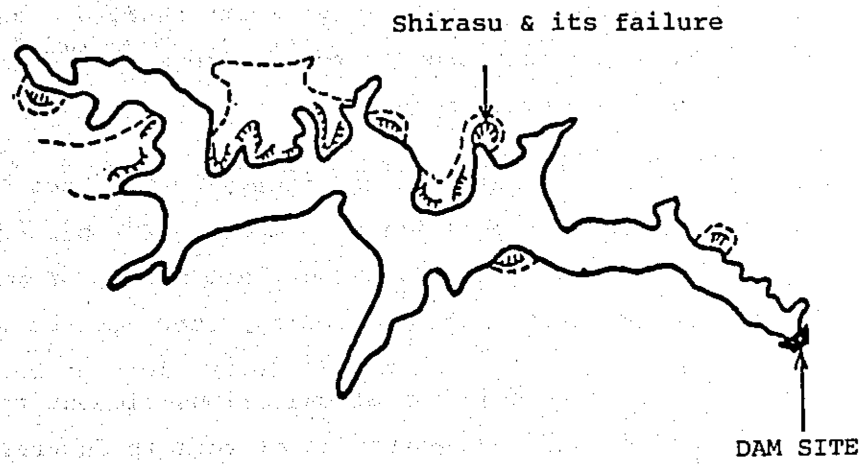


Fig. 6 Ayanami Dam

The geological view of proposed damsites of
Gandung and Jipang, Central Jawa

K. Uno
March 31st, 1976

Dear Mr. Ohba and Mr. Ishidoya,

Thank you for your kind guide to damsites, despite of your busy time. Next impressions are only depend on my observation in short times, so if some wrong idea here, I hope they will be amended in your field headquarter.

About Gandang dam

1. Environment of proposal damsite consists of Pleistocene or Pliocene i.e., limestone, tuff, shale. Consolidation degree of these rocks are weak in my view, but their bearing capacities are enough to support the dambody of fill type. Among them, young limestone may be pervious more or less. Therefore damaxis may be decided by relation of topography and accurate location of limestone.

2. If the spillway is designed as overflow type with shaft and guiding tunnel, bearing capacity of shale under foundation may be estimated from the result of Standard penetration test.

3. Weathered or flesh shale and tuff can get easily nearby, but I suppose they are not good so much for material of dambody. Its better to consider the limestone as a rock material and to carry out survey of coarse grain material as sand and gravel collecting now in river.

4. I have not known about the eluviation of calcarious element from the shale (calcarious mud stone) and weathering of rock in future. But it is doubtfull such chemical change acts so rapidly by water flow, I think. I hope to get some existing information about it, if possible.

About Jipand dam

I only have stood at right bank of proposed site, therefore I am afraid next comments are nothing but casual ideas.

1. Geological condition is supposed to be almost same in the vicinity, therefore the determination of site may be done from the topography as far as unexpected situation does not occur. However surface geological survey including distribution and thickness of terrace, river deposit or track of old river etc. is required. And survey area should be extended to both sides of dam. Result of survey will be useful for not only decision of damaxis but also finding dam materials.

2. At beginning stage, for this wide and long area, it will be planned to do physical exploration. But seismic or electric exploration are not always effective for such young geological condition. Its better to try their efficiency of each method on small scale. If not effective, geological survey should be chiefly done by boring.

3. One of most important problem are where, what kind and how many amount of dam material can be got nearby. I recommend to apply Unified soil classification to see the rough character of soil and it should be include coarse grain material like sand and gravel.

   Survey of dam material must be connected with surface geological survey closely.

4. Base rock of this dam is supposed to belong young strata of Pleistocene or Pliocene.

   Therefore layers of porous limestone or sandy gravel may occur frequently. So the districution, thickness and permiability of such layers must become subjects of survey, for their pervious character.

K. Uno
(Colombo expert in Bandung)

EXTRACT FROM:

"INVESTIGATION REPORT ON TRINGGADING IRRIGATION PROJECT AND KRUENG PEUSANGAN IRRIGATION PROJECT, MARCH 1976"

Introduction

This area is located about 200 km to the east of Banda Aceh. At Lubok Kareng of the river of Krueng Peusangan, a free-intake is planned intending water supply to 9,000 ha of which 5,000 ha is for Peusangan area and 4,000 ha for Pante Lhong area.

Pante Lhong area adjoining to the east of Peusangan area has a free-intake constructed in Dutch period, but it is now troubled with impossibility of taking water due to the degradation of river bed. A pumping station build up at the old intake irrigates no more than 300 ha because of its small capacity.

Therefore, Krueng Peusangan project also includes Pante Lhong area as the beneficial area. The total water requirement to be taken is 10 m^3/sec.

About 8 km of driving canal is partly under construction being excavated and shaped in natural earth without special treatment of the subgrade.

The designed route of the driving canal which consists mostly of sand and some gravel can be regarded as the original river bed.

Geological View of intake and channel of Lubok Kareng

1. Topography and geology

There are occured many failure and gully erosions on side slope of channel, especially at the beginning part of channel of 500 - 600 m. For the sake of interpretation of these phenomena, the topography and geology of this area should be explained at first.

Topographic elements of neighbourhood of channel consist of terraces of 3 steps i.e. high terrace, middle terrace, low terrace and their inter cliffs. (See Fig. A). Height of high terrace is 60 - 66 m, middle terrace is 40 - 44 m and low terrace is 33 m (height of low terrace is almost equal to flood height). Each flat plain of terrace is inclined a little to downstream - ward. High and middle terrace are separated by cliff (sloped cliff) of about 20 m height with 1 : 3 - 4 gradient, and middle and middle and low terrace by cliff of about 7 m height with 1 : 2 - 3 gradient.

Each terrace has a terrace deposit of some thickness underline its plain. Terrace deposits mainly consist of gravel and sand (old river deposit). And base rock (shale and sand stone of Tertiary) is occured under the terrace deposit. The boundary of them is generally irregular.

Origins of this topography are upheaval of land and erosion of river. In this topographic situation, intake is situated on base rock at A in Fig. A, B. Here the middle and low terrace were missing or not existing from beginning.

The beginning part of channel of 500 - 600 m from intake is situated from A to B in Fig. AB channel of next 2,500 m go through on C, then it reach to B' which is same to B in meaning of topography.

Therefore this channel may be said to be situated on middle terrace. As above mentioned, middle terrace is composed from terrace deposit and tertiary base rock. Its way of deposition is shown in Fig. C, but its thickness is changeable by locations.

2. Failure or slide of side slope of channel

Failures of side slope were occured most frequently on loose sand at the location of B. Its simplified section is shown in Fig. D.

Their causes are considered as follows.

1) In spite of the slope was composed by loose fine or medium sand (their standard gradient is 1 : 1.0 - 1.5), the cutting gradient could not be satisfied, perhaps because the terrace cliff of base rock was closed by.

2) Water on cliff and surface of terrace easily infiltrate into side slope after excavation of channel, and groundwater flowing on the base rock acts, as lubricant and causes slide from base rock.

Therefore the counter measures should be made proper gradient and effective drainage system for cutting and banking of side slope. For many gullies eroded by rainfall on the side slope, some slope protection such as sodding should be done.

3. Alternative of channel route

There is opinion that it's better to change the channel route in the base rock area to avoid the failure above mentioned and the leakage (loss of water) through terrace deposit. But this idea is not so effective because of following reasons.

1) If be selected on base rock, the length of channel will be about 3.8 km along the foot of terrace cliff and longer than present route of 3 km (from A to B').

2) Standard cutting gradient of base rock (shale and sand stone) is 1 : 0.7 - 1.2 and the slope of cliff is about 1 : 4, then volume of excavation will be much larger than present one.

3) Moreover there is possibility of land slide by excavation of foot of slope. Because these base rocks show a tendency of land slide. For example, we can see two land slides near Cot Mataie from the road to Birem. Anyway channel is better to be apart from foot of hill.

4. Leakage from channel

Within layers composed the middle terrace, base rock (shale and sand stone) is regarded to enough as impervious layer, but sand and gravel layer are previous layer and their permeability may become order of 10^{-2} cm/sec.

Therefore it's desirable to make lining for leakage, if not, it should be done after detail examination to seek amount of leakage.

5. Bearing capacity

Intake will be fixed on base rock. The depths of bottom of channel are almost deeper than 5 m, therefore bottom is always set on gravel layer or base rock. So there is no problem except for unexpected developments.

Problems

1. Slope failure of canal

Some slope failure can be observed at the upstream part where the leftside steephill is located close to the canal. Slope failure in the canal may occure also in future especially after water-flowing, owing to the steep cut of side slope and the property of sand.

2. Conveyance loss

The ground of the designed route consisted of sand and gravel is fairly permeable ranging from $K = 1 \times 10^{-1}$ cm/sec to 1×10^{-3}/sec according to the survey report. The conveyance loss ratio will be considerably high.

3. Degradation of river bed

Some traces of the degradation of river bed can be observed at the proposed free intake site. Although there is exposed base rocks, some consideration for the possibility of degradation in future will be necessary.

Proposals

The cross section of the canal executed tentatively is fairly small for steeper side slopes compared with the original design. The present capacity is 6.5 m^3/sec, less than 2/3 of the designed capacity 10 m^3/sec.

In order to satisfy the design requirement, to protect the slope failure and to reduce water losses, various types of lining canals are considered.

Materials used for linings include plain or reinforced concrete, stone masonry, brick, asphalt, synthetic plastics, bentonite, lime, timber, and soils. The typical types to be recommendable are as follows.

1. Compacted earth lining canal

Blending of two or more materials secures suitable soils for earth linings. The best results are obtained from gravels with sandy clay binder. The gravel particles provide good erosion resistance and clay provide imperviousness. Good stability characteristics are provided by the well graded sandy gravel fraction as well as the cohesive binder. The sand and gravels are obtainable from the excavation, but the clay will be conveyed from distance.

The proportions of the soils to be blended should be determined by prior laboratory testing. The compacted earth lining is placed in 15 cm, compacted layers to a depth of 0.6 m in the canal bottom, and a horizontal width of 1.5 m on the canal slopes. The side slopes above the water section are also protected with earth linings 30 cm thick with slope tamping and soddings.

2. Concrete lining canal

The advantages of concrete lining canal also include perfect savings of water, possibility of small canal sections and structures, higher permissible velocittes and steeper side slopes.

3. Concrete box culvert

In case of concrete box culvert, still farther advantages include lower operation and maintenace costs, and no danger of canal failure. The only problem will be the construction cost.

The others

1. Peusangan free intake

The location of the free intake shall be determined considering treatment of the sedimentation in front of the proposed site. The structure of the intake would be better to be designed so as to meet the conditions in case of weir construction in future due to the degradation of river bed.

2. Alternative for Pante Lhong area

Although water supply to Pante Lhong area is included in the Krueng Peusangan project, it is desirable to secure its own reliable water resource, unless the driving canal of Krueng Peusangan project is build up completely. The most suitable weir site shall be selected and surveyed.

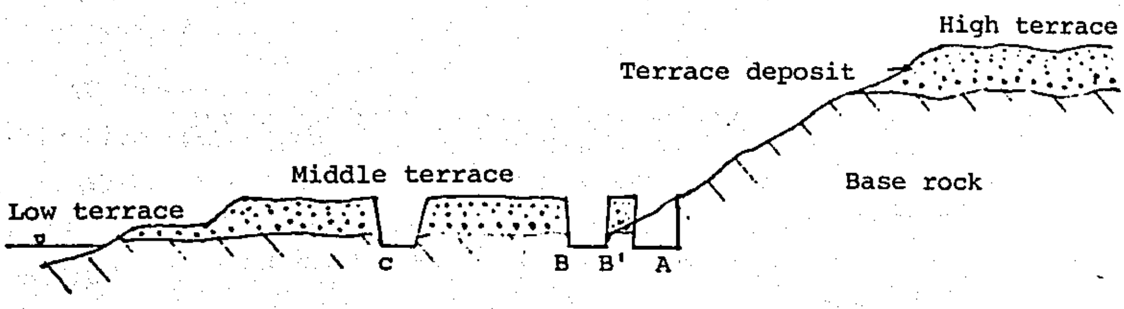


Fig. A Conceptual Section of Terrace

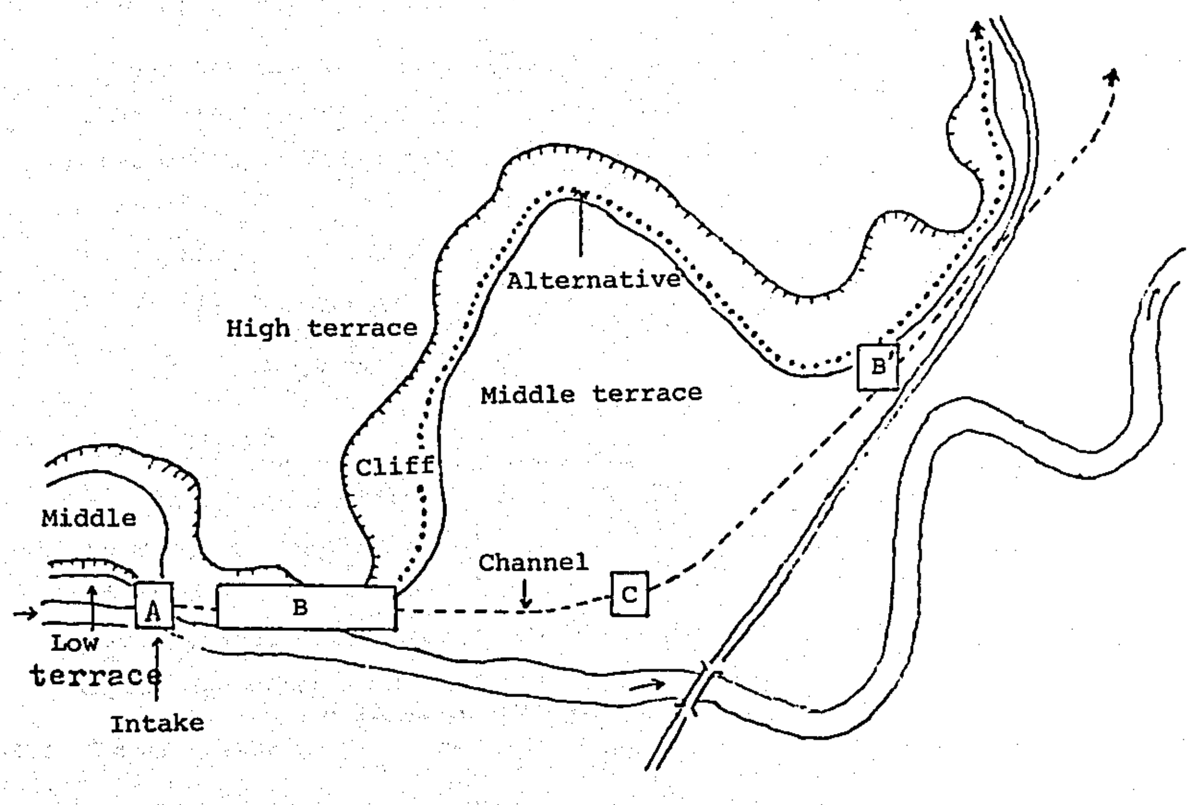


Fig. B Location of Channel and Terrace

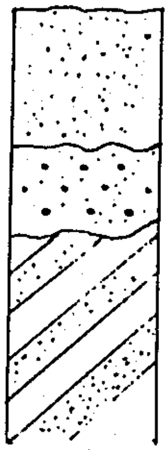


Fig. C Columnar Section of the Middle Terrace

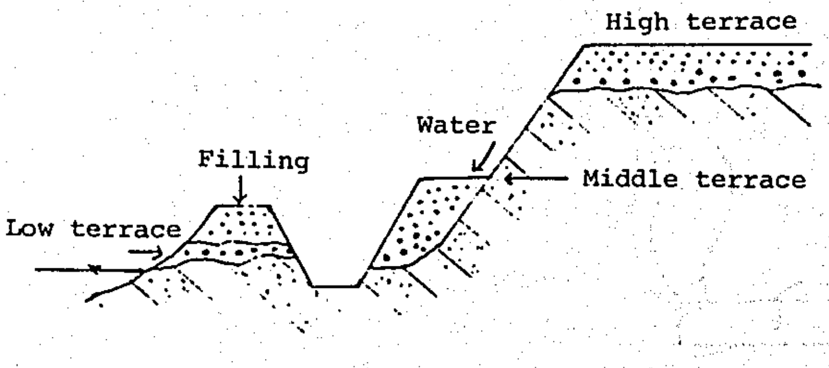


Fig. D Conceptual Section Vicinity of B

EXTRACT FROM:

"PROPOSAL SCHEDULE OF INVESTIGATION, PLANNING AND DESIGN ON THE LEMBOR IRRIGATION PROJECT 1976/1977, MARCH 1976"

1. Background of this report

At the end of last year, we were asked to go and see the Lembor irrigation Project in Flores island. Our object requested by Mr. Sadeli, the chief of the Planning and Design Service, Directorate of Irrigation, was to study the essential factors for making the master plan of the project.

The survey trip was carried out from January 5 to January 17, 1976. Since our return from the job site we are studying various items related to the project.

Apart from this work we were asked to make the schedule of investigation, planning and design on the project in 1976/1977 because the schedule for next fiscal year had not framed yet although the budget had been decided at that time. This report was made in the line with this request.

At the middle of February, we explained the skelton of this report to Mr. Wiyoto, the chief of the Rehabilitation and Exploitation Service, Directorate of Irrigation. It is said that this project is an urgent one, so the master plan is also desired to be made as soon as possible. But we are afraid that oneyear is too short to establish the master plan. Investigation and planning should be carried out effectively and systematically.

2. Investigation

The investigation items which are handled in this chapter are within the range of the technical aspects, i.e., civil engineering, geology, pedology, etc. It goes without saying that these items should be investigated carefully considering the other factors, i.e., agricultural, social and economic situations of the project.

2.1 Topographical

a. Basic topographical map

For investigation and planning of irrigation projects, first of all, we must get a proper topographical map (here inafter called "the basic map"). There are several kinds maps related to the project but only the following two kinds explained below are reliable.

General map (Scale 1 : 250,000)

This map covers the whole project area including the catchment areas of the weirs and it is considered the most reliable one. To grasp the general view of the project this is suitable but the scale is too small to do investigation, planning and sesign.

Detail map (Scale 1 : 5,000)

The mapping of this kind was executed by two organizations, i.e., PT. NINDYA KARYA and German Missionary. The mapped area by the former covers Wae Lombur and Wae Lombur and Wae Sele areas, and the one by the latter covers Wae Sele and Wae Sesap. Almost all Wae Sele area is double mapped by both organizations. Wae Cewo area is not covered yet.

Although we admit this map is very useful there are some faults which can not meet the purpose of investigation, planning and design concerning its accuracy.

The faults are as follows.

1. The contour line intervals by PT. NINDYA KARYA and German Missionary are 5 m and 10 m respectively. These contour intervals seem to be too rough to determine the block system for the benefited area especially for the flat part of Wae Sesap area.

2. There are very few control points such as bench mark and triangular point in the map. We can see only three control points in the map by PT. NINDYA KARYA and cannot find such a point in the part by German Missionary. (We can see many places having their heights, but they seem not bench marks but check points. Furthermore, by the explanation of the map the heights of these check points were measured by an altimeter, so comarative large error was considered to be unavoidable). Besides its accuracy there are following problems.

    1) The catchment areas of the existing and proposed weirs are excluding though they are indispensable factors to calculate the water availability of this project.

2) Wae Cewo area has not been covered by a such scale map. Considering the above mentioned problems a new map which has the following qualifications is require to be made in 1976/1977.

First of all, the areas related to the mapping should be cleared. We don't have any data about the existing mapped areas so we cannot help calculating the areas with a planimeter on 1 : 250,000 topographic map. Therefore, the calculation may be rough naturally, but we can get a general tendency of them. It is needless to say that these calculated areas should be checked again before actual mapping or modification. The total area required to be mapped is about 6,100 ha (See Fig. 2). About 2,200 ha in 6,100 ha has been mapped by PT. NINDYA KARYA. (A part in Fig. 2) and about 4,400 ha has been mapped by General Missionary. (B part in Fig. 2)

The total existing mapped area is about 5,700 ha because about 900 ha of both part is overlapped.

About 400 ha of Wae Cewo area has not been mapped yet.

1. The contour intervals of A and B parts should be modified to meet the purpose of investigation, planning and design. The irreducible minimum contour interval is considered 2.5 m in hilly region and 1.0 m in flat plain in Wae Sesap area.
2. To check the accuracy of the map easily and to utilize this map more effectively for the implementation of the project control points such as bench mark and triangular point should be prepared as much as possible. There is no standard about the number of control point but minimum number is considered 10 in the project area.

b. Measurement of catchment area

It is said that the budget in 1976/1977 cannot afford to map the catchment areas related to the project. But to grasp the catchment area conditions well is indispensable for the determination of water availability. Especially, the measurement of catchment areas is one of the most important factors to grasp the conditions, so it should be carried out by some meanings such as reconnaissance or ground survey with reference to 1 : 250,000 map or the aerophotographs mentioned below.

c. Aerophotographs

There are aerophotographs made by Dinas Topografi Angkatan Darat in 1948 (Scale 1 : 50,000).

The photographs related to the project area are six sheets. Three sheets of them are vertical and others oblique views. We are now going on with the procedure to get them and they will be very useful for grasping the geomorphological aspects of the project area and especially the measurement of the catchment area.

2.4 Land classification

This investigation is done on the basis of the basic map mentioned in the item 2.1. The investigated results is shown in the basic map, so the parts of the investigated area will be easily judged to be suitable to cultivation.

The land classification consists of the following four factors.

a. Land slope

The benefited area is comparatively flat, but there are steep slopes in the both sides of valleys and the foots of hills. In Japan, the area where the slope is beyond 15° is considered unsuitable for land reclamation to paddy field.

b. Soil depth

This is defined as the depth from surface to bed rock or gravel layer. In Japan, the area where the depth is shorter than 25 cm is considered unsuitable for land reclamation to paddy field.

c. Soil texture

This survey is done to see the aptitude of land reclaming to paddy and dry field and the estimate the water requirement in depth. At least, classification of sand, sandy loam, loam, clay loam, clay is necessary by counting clay content from grain size analysis about the dominant soil within depth of 50 cm. And its better to add the difference of volcanic, humus or gravelly character if possible. For examination of fertility and amendment of soil, chemical analysis is necessary such as potential of hydrogen phosphate absorption coefficient, exchange acidity, cation exchange capacity, humus content etc. Standard sampling unit area is 25 ha for the former and 100 ha for the latter in Japan.

d. Gravel content

This survey is done to dig a square hole (Depth 1 m, width 1 m, length 1 m) and to measure this amount of gravel, (gravel is defined as stone and rock of which diameters are larger than 5 cm). In Japan the area where gravel content percent is beyong 30 % is considered unsuitable for land reclamation to paddy field. About the above mentioned four factors the unit area of survey is about 25 ha in Japan, but the simplification or modification of above mentioned methods is admittable taking into consideration of the project circumstance.

2.5 Survey on New Weir

There are many proposed weir sites in the project area, but the following two weir sites are leading.

a. Wae Nengke Weir

This weir is strongly desired by Bupati of Kabupaten Manggarai and the proposed weir site is at the confluence of Wae Nengke and Wae Kanta. If the new weir meets the below mentioned checking points it will be an important irrigation equipment in the total irrigation system because Wae Nengke is the largest among the rivers related to the project.

1. Height Difference between River Bed and Benefited Area. When we visited the confluence during the trip, about 50 m was the roughly measured height between the river bed and the planes which spread on the both sides. Judging from the height the irrigable area by this weir will be comparatively far from the weir site. The fact will strongly influence not only the efficiency of the weir but also the posibility of the constructions. Therefore, the checking of the height between the river bed and the benefited area should be done first of all and secondly both profile and cross sectional levelings of Wae Nengke should be carefully done through several km in order to

select the best weir site.

2. Geological investigation at Weir Site

After the decision of the new weir site this checking point is desirable to be done. But this checking point may be put off in next grade considering the circumstance.

b. Wae Kanta Weir

This weir is proposed by Mr. X. Morel, the surveyer who made the map about Wae Sele and Wae Sesap areas, in his report. The proposed weir site is located near Desa Pela. We were not able to visit the place during our trip, but the following assumption will be possible from the map and geomorphological survey. The height between the river bed and the benefited area and the catchment area may be smaller than the case of Wae Nengke Weir. Such as investigation as Wae Nengke weir is desirable, but the main effort should be put on the discharge survey in this case.

2.6 Checking of existing irrigation equipment

For making the total irrigation plan, all existing irrigation equipments should be checked and confirmed their capacities.

THE REPORT OF GEOLOGICAL SURVEY ON THE PAMUKULU IRRIGATION PROJECT

I. Preface

From September 18 to September 25, 1975, three of us together went to survey and observe the Pamukulu project in Takalar South Sulawesi Province.

Our team was as follows:

K. Uno : Geologist, Colombo Plan Expert, Japan
T. Hartiwarman: Civil engineer, Counterpart
Sumaryono : Geologist, Counterpart

The aim of our trip was as follows:

Pamukulu weir site was altered from the first proposed one to new one which is situated downstream of 2.8 km from the initial one.

Preliminary design of new one was already done but it was designed without geological survey.

Therefore we were going to make sure the suitability of foundaation for the design from geological aspect.

If it need to execute some future geological survey, we were going to recommend about it (and additionally for aqueduct site too).

We finished our schedule of survey as follows.

September 20th:	Greeting and making previous arrangement with Mr. Suratman and Mr. Yasir at water resources development division
21st:	Survey on old proposed weir site
22nd:	Survey on designed weir site
23rd:	Survey on aqueduct site
24th:	Temporary report of survey to water resources development division

II. Newly designed weir site

This site is situated about 250 m upstream direction from Jene Mattalassa village, and about 2.8 km downstream from the first proposed weir site. According to the design, weir is coupure and fixed type. The length of coupure is about 240 m, the width of coupure bottom is 30 m (G.H. + 42 m), and crest length of enclosing dam is 100 m and dam height is 15 m (river bed G.H. + 34 - 35 m). (See Fig. 1)

1. Both banks of weir site are hilly area of relative hight of 20 m or so from river bed and slope down to river bed by 15 - 20 degrees.

2. Vicinity of site consists of volcanic breccia (intermediate or basic rock, belong to Miocene-Pliocene) and almost lacks weathering layer. Only near by top of both banks we can see the residual soil of 30 - 50 cm thickness including many pebbles and cobbles, and there scarcely exists the river deposit with some boulder.

   Estimating from appearance, the compression strength of rock may be more than 150 kg/cm^2 and permeability of rock may be very low, so the design of fixed type is proper for this site. At the end of downstream of coupure, it need not to consider the special protection for shooting flow. For excavation it needs to use some explosives.

3. Leakage that may cause difficulty for intake is hardly considered at the present time.

   Unsuspected leakage is rarely occured in volcanic rocks. Though we found some fairly large crack on site, making a through examination for the pressence of leakage is much expensive. So if such trouble occures after construction, its better to be handled then by some counter measure.

4. Excavated rocks will be mainly used as dam material. If soil will be used as shielding zone, as there is no thick weathered layer near by, it must be investigated to look for soil which can be collected in a mass.

   Probably it can't be get from weathered layer but from terrace deposi deposit. There may be no serious problems refered to dam foundation. Any way as a matter of course, some borings and soil mechanic test should be done for design of dam.

5. As for the type of driving channel succeeded to weir, the selection whether it shall be open channel or tunnel will depended on their construction cost.

6. (Additional note about old planned site)
Discharge survey has been carried out by Directorate of Hydraulic Engineering Bandung at Pesanggrahan situated downstream of 1.4 km from this site.

Geological investigation at weir site has been executed by C.V. Geoteknik and mapping along the river was finished by P.T. Tricon.

This weir site was abandoned for the reasons that driving channel was too long and channel route was situated to steep slope. According to geological survey, the weir site should be designed for floating type (river bed G.H. + 52.00 m).

As there are some incomplete or misunderstood descriptions in "Interim report of Geological investigation", we directed to reexamination.

III. Aqueduct site

This aqueduct will be constructed on downstream of 3 km or so from newly proposed weir site, or lie in east of 1.5 km from Mancong Komba village.

Route of channel is not decided yet, then accurate site of aqueduct is not determined. For planning on design of aqueduct and channel, it seems useful to have a conception of general geology and geomorphology about this area. (See Fig. 2)

1. Plain of bothsides of river is roughly distinguished to two terrace plain i.e. plain I and plan II.

Plain I is mainly distributed at right side of river and Plain II is at left side.

Plain I is higher than plain II by 2 - 4 m.

River deposit is seemed to be a little on river bed. The width of river is about 20 m and wetted perimeter is about 5 - 7 m in the survey time. River deposit is seemed to be a little on river bed.

2. Plain It is consisted of volcanic breccia which is belong to semi-hard or hard rock and surface soil is scarecely. Plain II is consisted of terrace deposits i.e. soil layer (thickness is 1 - 4 m at outcrop) and gravel layer (thickness 1 m at outcrop).

3. In any case, so far as pier and abutment of aqueduct, bearing capacity or shearing resistivity required for foundation is not so much.

   Volcanic breccia is enough and gravel layer is perhaps enough as bearing layer. If there is no need to select the channel route for special construction, its enough to examine the form and strength of foundation at the very spots.

Fig. 1 Geological Profile of Weir Site

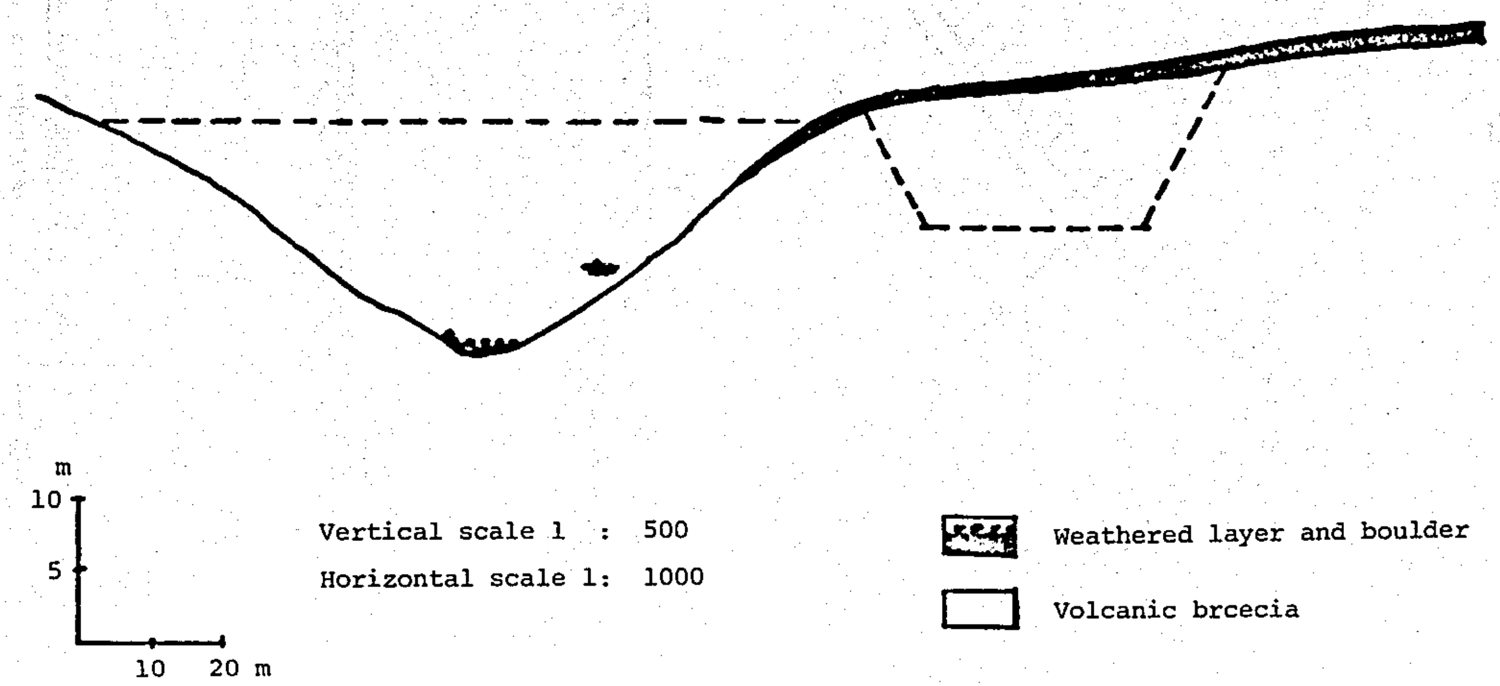
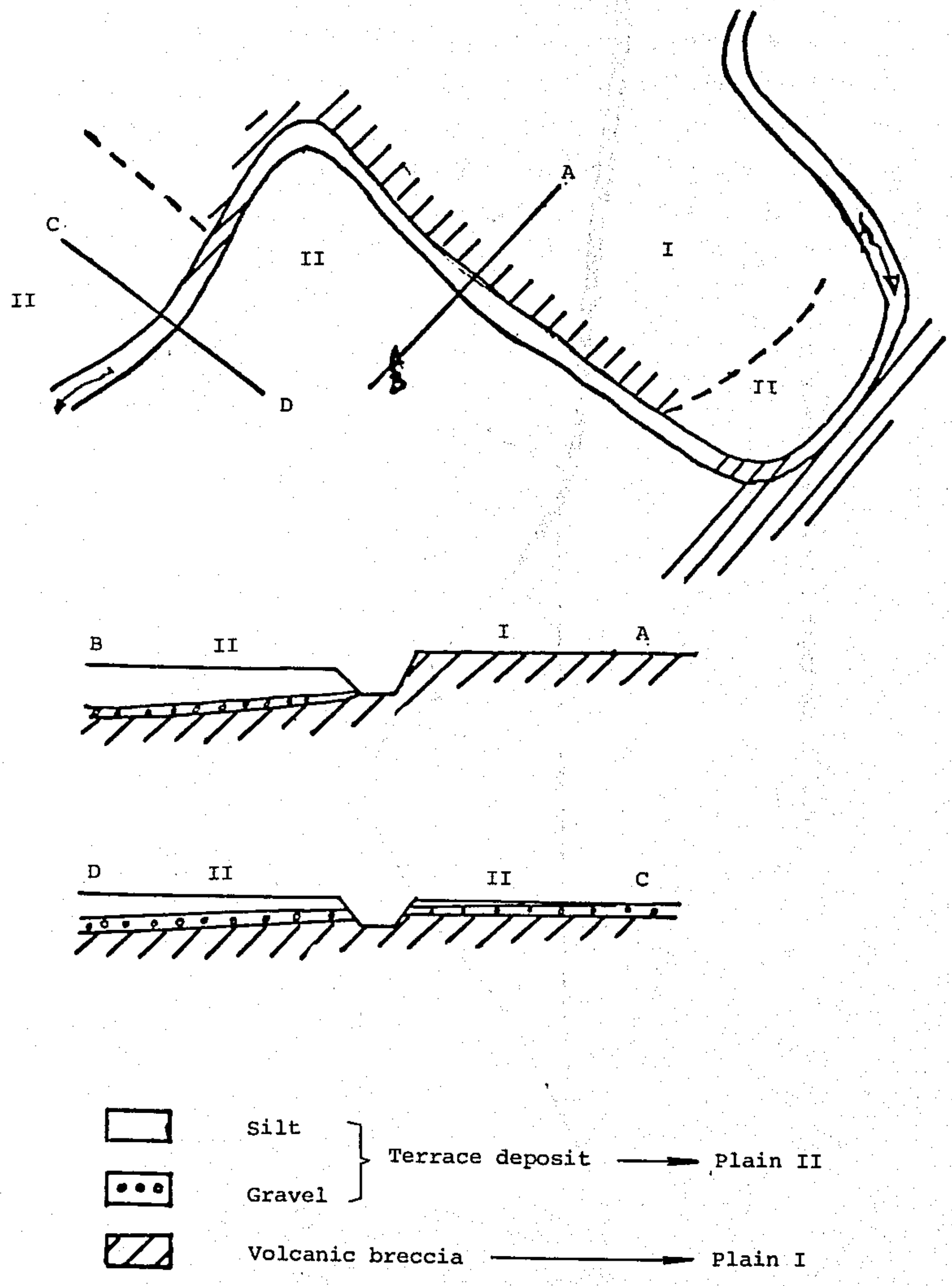


Fig. 2 Geological Map and Anticipated Profile
(Sketch)



EXTRACT FROM:

"TECHNICAL INVESTIGATION REPORT ON THE TLOGO PROPOSED DAM, JUNE 1975"

I. Location and topography

The proposed Tlogo dam site is situated about 20 km to the south of Rembang, Central Java. The catchment area of the proposed dam is 12.60 km^2, extending about 6 km from east to west and 2 km from north to south. It shapes a complicated hilly land with gentle slopes surrounded by low mountains, 200 m to 300 m in elevation.

The proposed dam site is located at the place where the Besek river flows into the valley stream gathering water from the whole catchment area. The area spreading above the dam site shapes a wide area with gentle undulations, so it will possibly form a good reservoir basin. While, the valley proposed the dam construction is so narrow that the length of dam crest will be about 70 m for 20 meters of dam height. Therefore, it can be said that the proposed dam site is topographically effective and suitable.

II. Geology

1. General geology

The proposed irrigation area and dam site are parts of the regional geology of the hilly district of Rembang. The hilly district of Rembang consists of a number of more or less east and west trending ridges alternating with alluvial plains. The hills almost reach the north cost from which they are separated by narrow sandy beaches. The general geologic structure of that area is called Rembang Anticlinorium which consists of folded sedimentary rocks e.g.: sandy limestone, limestone and marl.

2. Geological condition of the proposed dam site

The proposed dam site is located at the narrow Kalibesek valley with the steep topographical condition at the left and right side banks. That topographical condition is suitable for dam construction. The abutment, left and right side are limestone ridges with trend east-west, similar to the strike of the layers.

According to the short observation at proposed dam axis, two kinds of limestone are exposed. Firstly, the lower part is sandy limestone and secondly is "Karren Limestone" at the upper part. The physical properties of those limestones are hard and sometimes massive if they are still fresh. There is no foundation problem for supporting the dam body, because the bearing capacity is high. But usually in area where limestones preveil the limestone has possibility to weathered and to be caused cavity, sink hole etc. Therefore if such phenomena occure at this damsite and reservoir area, it may turn out to induce leakage. This is one subject of survey. According to our short observation, the large amount of good quality earth for dam material will not be expected. It seems that alluvial or volcanic origin soils are not so abundant and wheathered soils come from Tertiary sediments are not good q-ality. This is another main subject of survey.

V. Conclusion and recommendation

1. Conclusion

(1) Topography of the proposed site will be suitable for dam construction.

(2) However, the construction costs of the diversion tunnel and the spillway will be comparatively high.

2. Recommendation

(1) The observation of water level and discharge measurement near the dam site or the Simoturu weir are necessary.

(2) Geological and soil mechanic investigations must be carried out as follows:

a. Detailed geological mapping at the dam site and reservoir area including: kind of rocks and their extent, geological structure (fault, joint system, fractures), geomorhpological phenomena (sinkholes, caving, landslide etc.)

a.1 Existing stratigraphic datum of nearest place from reservoir is required, and in comparison with layers of dam site and reservoir, rough guess about latter horizons and bedding conditions should be gotten.

a.2 From whole geological structure of the hilly district of Rembang, the meaning of geomorphology about the ridge of damsite and reservoir area (and general alternation of E - W trend ridge and alluvial plain) must be interpreted. This geological structure may give suggestion about the leakage from reservoir and distribution of alluvial soil.

a.3 In case of engineering purpose, geological map must be surface geological map. It must contain rough extent and depth of surface soil or weathered soil for construction materials or for excavation. And it is desirable to write about various surface phenomena, e.g. characteristic of land slide or huge limestone in settlement. About the survey of sink hole or cave for leakage, it is necessary not only to make field investigation but also to get information from old village men.

a.4 Neighbourhood of damsite will be mapped by large scale (about 1 : 500). By this map, detail geological mapping shall be done. In our observation, trend of layers change as follows from downstream to dam site: N 90° E/15° - 17° N (sandy tuff, weir site, 300 m from dam site), N 75° W/30° N (30 m from dam site), irregular but almost vertical (limestone, dam site). From these feature, some special structure is expected at dam site. That structure, kinds of rock and system of crack etc. are important to see the characteristic of leakage, and these must be made clear before design. Core boring shall be planned for the purpose to assure the temporary geological interpretation gotten by survey.

b. Core drilling along the dam axis for subsurface condition of the foundation rocks (porosity, permeability etc.)

c. Construction material

It depends on the type of the proposed dam. Location and quantity of soil, gravel and rock. Soil mechanic laboratory test of soil derived from weathering marl. That kind of soil is abundant not so far from the dam site.

c.1 In case of this dam, dam type will be decided rather by quality and quality of available materials around the dam site, so survey of construction material is important.

c.2 Course grain material shows more sound stability than fine grain one as dam material, therefore in my opinion it is not too much to say that soil mechanic survey should put stress on looking for coarse material like sandy soil, sand gravel and rock in Java.

c.3 In first stage of survey, it is essential to make rough estimate about volume and characteristic of material extending over wide area, so that it is desirable to apply unified soil classification method.

EXTRACT FROM::

"TECHNICAL INVESTIGATION REPORT ON THE PAKISBARU PROPOSED, DAM, JAN. 22, 1975"

Geology

1. Outcrop

The rocks of this district come under Tertiary, Miocene system. They are mainly derived from volcanic material, such as Breccia tuff, tuff, basaltic lava etc.

a. Weathered tertiary

Above mentioned rocks are weathered severely and deeply, for instance, basaltic lava at right bank of damsite can be stripped off easily by finger tip but remains its original rock texture. Also breccia tuff or tuff show the same character. Around the reservoir, only small outcrop of hard basaltic rock is found near the nothern spring.

b. The upper most part of above rock is affected by lateritization and show reddish colour. Its thickness a few meters but some time it is lost by erosion.

c. These weathered sediments above mentioned are covered with brown soil. Brown soil originated from volcanic ash. It almost cover all the surface of topography. The thickness of brown soil is 0 to a few meters according to the topography. Some times, for example west hill of reservoir, it reaches more than 5 meters in thickness.

2. The base of dam axis

Rice field lies in most of valley bottom and river deposit will be thin. It's supposed weathered breccia tuff or something like that will be under the river deposit and we cannot reach fresh hard rock within a few meters depth, I think. Both abutts of dam are the same as the case of river bed. It will be question how much bearing power they have.

3. Dam body material

We couldn't find good material for dam body nearby. So we think, it's inevitable to use the same material as foundation. These material, brown soil, red soil, weathered tertiary are abundant near reservoir. But, as I said, they are all derived from volcanism, then they are sometime contain many decomposed glass. So they may be not so well for construction, in my experience in Japan.

4. Others

a. The leakage of water from reservoir

In such area which consist of various volcanic materials, I am afraid water leakage occurred from reservoir, especially like this situated on the top of hill. If water percolates so much downward or sideward through the rock, usually run off of such area almost cannot be seen in dry season, but in this area it is known that run off of dry season is one third of wet season. I am not worry about that so much, but it will be necessary to study the permeability of rocks.

b. The land slide

We can see two land slides near the reservoir. I think their sliding plane is in shallow depth and their sliding ranges are not so large extent but we need to consider some counter-plan similar to soil conservation or erosion control.

5. The course of investigation will be shown in attached paper

Dam location

As for the two alternatives proposed for dam construction, the downstream site (alternative I) needs to construct a large sized secondary dam which is in danger of sliding down along the steep slope outside of the reservoir basin. While for the upstream site (alternative II), it is rather possible to construct a dam, although the height of dam shall be restricted by the saddle at the right slope of which the height is about 15 m from the lowest place of the dam site. Since a more favorable site cannot be found around the area, alternative II will be decided as the suitable dam site. And the site of the saddle should be carefully studied geologically.

Dam type

A homogeneous type of earth dam can be considered to construct a dam, due to the soil condition that it seemed to be the same kind of clay around the area. Clay is practically impervious, but it is highly absorbtive. When saturated, it tends to become fluid, it is slow to drain, and its cohesive and frictional resistances are greatly reduced. In case of a homogeneous type of earth dam, sufficient drainage facilities must be equipped, such as stand drain, horizontal drain and toe drain. Materials for these drains and filters must be sought out in the vicinity and their characters and mechanics must be studied.

Nawangan project

Geological constituents (fresh miocene rock: breccia tuff, basalt etc.) are good for base of dam. However, assuming the dam construction at the proposed site, the storage capacity will be less than the volume of dam body. For instance, in case of 30 meter dam height, the storage capacity will be 126,300 m^3 and the volume of dam body will be 144,600 m^3, as shown in Fig.   . So, it is not suitable for dam construction. The alternative measure will be weir construction.

Ngromo project

Wide outcrops of basaltic rock can be seen on the river beds of two sites proposed for weir construction. The suitable weir site should be decided in accordance with the elevation of the beneficial area. Although some parts of both bank are covered with soil or plants, the shape of rock will be easily found by trenching before design. (Please refer to 3-2 about investigation of weir.)

Investigation plan for Pakis baru dam

The following plan will be desirable upon our rough survey mentioned before. Its fundamental ideas are to get information about,

1. Bearing power and permeability, as dam base.
2. Physical and dynamic character of soil, as dam material.

The former is mainly executed by boring taken with penetration and permeability test, while the latter mainly examine in the laboratory. These results shall be very useful as analogous data for small dam construction on tertiary stratum in future. It is enough to decide the location of borrow after the soil test because dam material may be poor quality but plenty and can be found anywhere.

1. Boring: Location (on dam axis and spil

   a. Right slope (15 m high from river bed) length 20 m
      River bed (20 m from foot of right slope) 20 m
      River bed (20 m from foot of left slope) 10 m
      Left slope (15 m high from river bed) 10 m
      Spillway 10 m

   b. Permeability test

      (every 2 - 3 m length in boring hole)

   c. Standard penetration test

      (at 0.5, 1.0, 1.5, 2.0, 3.0 m depth, under 3 m at each 3 m depth)

2. Soil mechanic test

   a. Sample
      Brown soil 3 sample
      Red soil 3 sample
      Weathered tertiary 4 sample

   b. Item
      Natural water content
      Grading
      Liquidus and plastic limit
      Share test
      Compaction test

3. Supplementary note (1)

   a. If the core recovery is not enough, it needs to use double core tube or to bore without circulation water.

   b. By pressure method, take care to prevent to make clayey hole wall.

   c. Describe the name of method.

d. Necessary to select the samples showing different appearance at different place. Sampling location must be pointed out on map and be taken colour photo (close up). Sampling of dam materials usually needs the direction of either geologist and soil mechanics engineer about their locations and specimens in field site.

e. Natural water content is also important for embanking. By grain size and consistency test, identify the name of soil according to unified soil classification. By compaction and share test, decide the design value, e.g. density, friction angle, cohesion etc.

4. Supplementary note (2)

If possible, it's desirable to add next survey,

1) Borrow

For body materials. If above mentioned soil test are not finished yet, we must assume the locations depened on its economical and community's interest view. On these assumed locations we shall examine the kind of soil, the thickness and extension by boring, augar or test pit method.

2) Stone

For stone pitching (masonry work) to protect spillway and dam toe. By geological survey we can expect some suitable kinds of rock, e.g. basaltic rock, tuffucious rock or limestone. But it needs to have some hardness and to get inexpensively. Then sometime we might need compression test or boring to detect the overburden.

3) Sand and gravel

For drain. If we cannot find the proper location of sand layer or deposit by geological survey, we have to bring them a long way. We might need grain size test and some volume survey.

About above mentioned survey, the report should be summarized after the following items.

Location, topography. Borrow or quarry size. Geological condition, quality, available volume, degree of difficulty to work, transportation (road), purchase price.

Advice for investigation Jan. 22, 1975

1. Dam

Generally speaking, there may be only two geological types about dam basement in Jawa. One is Tertiary stratum and other is volcanic rock or sediment. So I guess there are many data concerning both the character of basement and body material of existing dams in each geological condition. If we have the inventory of such data, we can get easily rough guess about proposed dam condition. For example, we could find the bearing capacity. permeability or various soil mechanic characters of Tertiary rock similar to Pakis baru dam in it. If not, we have to start from the beginning and investigation cost will be expensive. Especially, in my case, I don't know any specialties of geology or soil mechanics for dam construction are here. So my first step to do, should be collection of every data about existing dams (I think it's enough to be after independence)

The item to be collected, may be followings

1) Dimensions of dam (name, catachment area, flood volume, storage capacity, height, length, volume content, construction period, cost etc.)

2) The reasons why that location was settled

3) The reasons why that dam axis and dam type were settled

4) Geological map

5) Geological profile (including investigation)

6) Designed or executed profile (dam arrangement, foundation treatment)

7) Physical properties of base and dam materials (quantity of investigation and their results)

8) Design values and executed value for calculation of slope stability

9) Foundation treatment (method and cost)

10) Problems under and after construction

11) Observation datas after construction

If such inventory is already provided for general use, I must get it as soon as possible, if not, we have to find the way to collect these data. I hope to be guided how to get them.

Above mentioned items are only related to geology and soil mechanics, but data about hydrology, design or economy are needed for every one. So it may be the best way to attempt and summarize the whole situation and tabloid as inventory. But it will not able to do by one man, it will need cooperation with engineers in different section, especially one who knows well where these data are and how to get them easily. I hope you will understand its necessity and recommend the good way.

2. Weir

At my first courtesy, Mr. Oesman, Director of Irrigation, told me that my first work in this country might be to make the guide-line to geological investigation for weir construction.

In Japan, geologist is demanded to get following data.

1) Geological profile

2) Permeability

3) Bearing capacity

4) Grain size accumulation curve, sediment load, and its foundamental guide is shown in "Manual of Planning and designing.
Head work: Ministry of Agriculture and Forestry Japan".
So it is not so difficult to excerpt geological matters and bring conclusion.

But when I heard that request, I wonder what problems happened and what specialities are here. My first step must be to collect the failures instances as many as possible. Because, the aim of investigation is to prevent failures, on the countrary that failures show the guide line of investigation.

By chance, I had a time to talk about Ngromo weir in Pakis baru district with Mr. Sadeli, Chief of planning and designing service, he suggested the severe effects of souring on river bed rock which were occured in Central Java.

Generally speaking, scouring means the fact that, by its mechanical force, the river flow digs up and washers away soils and sand gravel. I have not heard about rock. I don't know what kind of rock can not bear against the destructive or tractive force of severe flood flow and how to decide the necessity of riprap or apron.

Its difficult to detect the durability of rock for scouring theoretically, we had better to perform following study then.

1) Make a list of damaged weirs

2) Classify the causes from the geological and soil mechanical aspect.

3) Observe the geological condition at affected or non affected weirs on the point of scouring.

4) Sellect typical rocks from above mentioned weirs.

5) Test for abrasion and compression.

6) Decide the safety range of rock strength for scoruing.

Abrasion and compression test, either of them are included in concrete and its aggregate tests. Abrasion test (by Losangels machine, JIS 21, ASTMC 131) does not show the bearing strength for scouring directly but character of this test have some resemblance to it. Conpression test (JIS 33) is very simple test and if we can get some correlation between these two tests we can easily judge the strength by compression test.

3. Investigation

Some times I was asked at field site whether we could construct the dam at this location or not. But these questions are always nonsence. Because we can construct the reservoir at anywhere or at any geologic condition, if economic consideration could be excluded.

In our investigation, especially about looking for damsite, sellecting damsite from proposed ones or planning on geological view, we cannot neglect the designing aspect, and design always be based on economy. At least, before beginning of investigation we need to assure the outline mentioned below.

1) Purpose of project

2) Required water volume, reservoir capacity

3) Height of intake

4) Proposed damsite

5) Being based on project plan, we may need some dam, but we must know its degree of necessity, whether its necessity is absolute or not.

   If the cost exceeds the estimate we may change or abandon the plan.

   And also, to get information successfully, we are always necessary to consider how to use the investigation budget effectively.

   Lastly, let me add a few words for transfer of knowledge or technic of engineering geology to a counterpart. He must make a plan, perform and write the report for investigation as for as he can. If he does not try that, he cannot make progress rapidly. He should not be a socalled counterpart but he is a mainpart and I expect myself to be a good adviser.

ABOUT THE SINK-HOLE OCCURED AT DARMA DAM.

April 4, 1975

1. Such phenomena are often seen in area being covered with volcanic unconsolidated sediment, i.e. volcanic ash, sand or gravel. The process is considered to progress as follow.

   a. Groundwater flow down in heterogeneous, pervious medium

   b. Partially piping occur and remove fine soil particles

   c. As time goes on, the amount of lost material increase little by little and water vein (fissure or crack) is formed by

   d. Partially cave is formed and grow larger

   e. At last, the overburden is depressed into the cave

2. In case of Darma, its process is the same but its conditions are rather artificial. Groundwater may come from reservoir or rainfall and sink-hole was formed in toe drain and fill being made up of volcanic materials.

3. The seepage route from reservoir may be considered through banking earth, rock, their contact part of foundation (natural ground).

   But the seepage is not seen at the foot of slope below the toe drain in spite of comparatively high water level of reservoir. And as far as we have observed the sink-hole, we could not find any water.

   It does not show constant water flow. Under special condition as heavy or continuous rainfall, waterflow occur in drain and percolate down to the fill which compaction was not sufficient to prevent it.

4. To prevent the water concentrated in the drain from penetration into the fill, the drain must have an impervious layer (i.e. clay, asphalt, vinyl and so on) and layer do decrease the velocity of percolating water at its bottom.

5. Under these conditions, this drain may replace with catch channel within the range of filling ground.

But in the range of earthdam, if the saturation line reach to the drain, the facility must have two functions, namely toe drain and catch.

6. Whether the toe drain works to collect the seepage or not, will be easily detected by augar hole having one or two meter depth at upper side near the toe drain when the reservoirs shows high level.

MY IMPRESSION ON THE REPORT OF JRAGON DAM

(Flood control and irrigation project, Feasibility study (Aug. '73))

K. Uno

Nov., 1974

- As the stuffs of study of dam geology for us -

This paper is not my evaluation or appraisal to the report. Technique of fill type dam is not always explained theoretically, so we are necessary to accumulate the precedent actual instances. In my case, I don't know about real dam construction in Indonesia, then I would like to aquaint with common knowledge about engineering geology or soil mechanic in Indonesia.

Reading through this report, I have some questions or points which I am difficult to understand. Of course, to understand this report, I need to refer the following reports, but I have not done yet.

1) Reconnaisance survey Djratunseluna area, Oct. '68

2) Feasibility study, water resource development Djragung, Dolock and Penggaron basin, Dec. '71

3) Pre feasibility study, Rawa Penning, Feb. '72

4) Djratunseluna basin development plan, Jul. '73 (Report IV, V)

A. Miscellaneous geology

1. Geological field mapping on aerial photo (e.g. 1:20,000, 1972, 1:6,000, 1973 in the report)

In every project area, is it the rule to ready aerial photos, can you get it easily? From where and how much.

Show me some example of its geological map.

2. Spine of Jawa

Relation between main watershed, river distribution and orogenic belts, is there any crustal movement data detected by Geodetic means)

3. Higher terrace

Classification of terrace surface (plain) and its position in quarternary research. Coral distribution, active faults etc. Distribution map of Delluvium and Alluvium, volcanic flow, fall deposit, peat or soft soil etc.

Can you compile from literatures?

4. Sea arm

Development of coastal plain & alluvium plain relation to the land use (e.g. East Sumatera and North Jawa)

5. Earthquake

Critical type and shoch type

6. Marl

Field idnetification from mudstone or shale ($C_a\ CO_3^{30}$ - 70%) content)

7. Shallow hole

Observation to evaluate the danger of sliding

8. Unit cost for investigation

Integration procedure (efficiency per unit work) in Indonesia

B. Appended figure

Its difficult express the details in statement accurately, preferable to illustrate by figure as much as possible. Generally, report should be provided following.

1. General geological map 1:50.000 - 100.000 level or so

   Indicate catchment area, beneficial area, reservoir area, sites proposed to dam, borrow, quarry and other main construction such as headwork canal etc.

2. Reservoir geological map. 1:25.000 level or so

   Dam, reservoir area, borrow, quarry should be written on. Be desirable subsurface geological map (include detailed quarternary and wethering crust) than traditional geological map.

   e.g. the stratum or locations of fault about sliding in the report.

3. Damsite geological map 1:500 level or so

   Outcrop and locations of tests, outline of dam arrangement, sometime test spots which recommended in the report.

4. Geological profile (along the axis direction) 1:500 level or so

   Surface soil, river deposit, terrace deposit, geological structure, depth of wethering (e.g. complete 3 m slight 10 m) fault or brrecciated zone.

   Boring, pit location, permeability, bearing capacity, core recovery, other results of physical test.

5. Geological section

   The same as above.

6. Planning of execution

   This is often indicated on 3.4.5 figure.

   Depth of excavation, planning of grouting, blancket, water stop or other foundation treatments.

C. Physical property of base and dam materials

We need precedent actual datas and values, these are more precious things than values in text book and these accumulations will lead you to new aspect of engineering geology in Indonesia.

1. Permeability

a. Is there any standard specification in Indonesia about practical operation and its calculation

b. About three methods in the report: fall head, constant level, pressure.

c. How execute or comprehend in case of Page III-4 soft formation and Page III-11 lost circulation.

2. Core material

a. According to unified soil classification, CH and its average Wo 25 ± 1.2% but in the report Wo 15 - 21% and natural water content is unknown, it means the difficulty of banking management.

b. How many workable days in a year for core banking in Indonesia.

c. According to American Reclamation Bureau's table (grain size accumulation curve) they situate beyond or near the upper limit of core range, it means the danger of 1. crack 2. slide.

d. Page III-15 gravel size particle was eliminated, if so perhaps meaning of grading curve almost be lost, strength or permeability of soil will change.

Do you know some relation between eliminated one and real one?

e. About swelling pressure test: its operation, its meaning for dam construction, relation to triaxial test (consolidated type-triaxial test)

f. The necessity of consolidation test (total settlement and time/consolidation progress) in this investigation stage.

- Geological investitation cost
  - Investigation cost
    - Direct cost
      - Personal expense
      - Material cost
      - Motive power cost
      - Machine and tool
      - Loss compensation
    - Indirect cost
      - Preparation expense
      - Temporary construction cost
      - Carriage cost
      - Travelling expense, days wage, hotel expense
    - Contingency
  - Technical work cost
    - Technical, analitical work
      - Direct personal
      - Expense
      - Contingency
      - Payment for technic travelling expense etc.
    - Writing report
      - Drawing
      - Typing
      - Photographing
      - Print
      - Book binding

Average unit cost: Survey (for geological mapping)
Boring
Test pit
Permeability test
Standdard penetration test
Geophisical explocation (Seismic & electric)
Rock tests
Soil tests
Grout test (and grout for construction)

3. Dam body material

a. Rock: sand stone, thickness 9 m, height 50 m wall, dip 55°
required volume 2,620,000 m^3, how to excavate? Is there?

b. Some standard about bulk factor of soil (e.g. 1.0 : 1.2 : 0.9)

c. Gravelly material: Natopuro formation (300 m, agglomerate)
stripping depth unknown, average thickness 1.5 m, so need wide borrow size. How to excavate?

Grading curve is needed for data of good quality at least (e.g. at Nglanyi site granule, pebble, cobble 65 - 80 % how about fine grain)

4. Design value of core and dambody material

a. Let us collect the datas about the constituent material of the exist dam. Fill dam tecnic is formed by many empirical elements and it's important to look for good borrows for us.

b. The decided reason of design value of untested material should be presented with precedent analog us instances.
(e.g. in the report)
rock: $\emptyset$ = 35, natopuro formation $\emptyset$ = 30 γw = 200 ton/m^3
base: γw = 1.8 t/m^3, $\emptyset$ = 20 - 24 (1^0 increase depth every 5 m)

5. Filter material

a. What processing to get filter material at borrow II

b. Unit cost (e.g. in the report, filter and riprap are 2 times as much as gravelly material)

c. How is the status of supply of sand and smashed stone in Indonesia.

6. Description of materials

Location, borrow size, quality, quantity, reparation thing, transportation distance and road.

7. Stability calculation

a. Regulation in Indonesia about safety factor, is there difference at stages of study?

(e.g. in the report)
Up stream slope after rapid draw down 1.4
Down stream slope under full reservoir 1.6
In Japan 1.2 in all case

b. Earthquake factor, how to use it for design
(e.g. 0.01 - 0.05 cm/sec)
in Japan, use seismic intensity = maximum acceleration of earthquake/acceleration of gravity

c. Seismic expected area map was compiled in?
Sutadi: Compilation of data on important earthquake since 1900 recorded by the M.G.S. 1965
Boem : Brief outline of seismicity and earthquake, engineering problem in Indonesia 1971
Relevant literature: Japan Architectual society, Article No. 60,
Tazimi: How to calculate the maximum seismic response of archtecture by statistic method, (seismic accelaration ground factor response).

d. Some question to calculate safety factor (stability calculation) in this stage

8. Supplementary survey

a. Boring or other test should be always have high accuracy, and with the progress of sujvey we add their numbers and get good probability.

b. Happening of new need for survey

c. Supplementary problem (e.g.) foundation of water power construction, protect erosion

D. Items which should be contained in the Geological report

1. The details determining the dam site

a. Need comparison with other proposed damsites

b. Location, topography, geology, foundation treatment, material supply and other economical comparison (e.g.) in the report:
Not enough about quantity of dam material, hauling distance is

far, foundation treatment (if include for sliding) is more expensive.

2. The details determining the axis and type of dam

   a. Relation between axis, topography, geology and dam type

   b. Concrete or fill type? Homogeneous, zone or core type? Arch or straight type?

   c. Slope (upstream, down stream)

   d. Should be added water quantity/water level (= g/h) curve

3. Spillway, cofferdam

   a. Suitable location for spill way is depend on its base rock and topography, often be required model test before final design.

   b. Any regulations about return period for design capacity of flood discharge, spill way capacity or temporary diversion canal.

   c. We had better to remember as our common sense design flood discharge per km^2 every district at Jragon e.g. 60 m^3/sec.

   d. Flood control gate, emergency spill way in the report.

4. Dimensions of dam

   a. By form of table, we can see the outline of construction plainly.

   b. Catchment area (e.g.) km^2

      Flood volume (e.g.) m^3/sec.

      10, 25, 100, 200, 10,000 year return period.

      Total storage capacity, available storage capacity, dead water, siltilation (sediment).

      How long are the life of the dam or other construction in Indonesia.

      Height of dam, length of crest, dam type (slope), volume content (core, transition, rock etc.)

   c. Execution plan

      Excavation: Depth, volume

Grout : Arrangement disposition (depth, number, total length, requiring cement)

Other foundation treatment: waterstop, branket, etc. How to protect the sliding, how is the flatten work and its excavation volume in the report.

5. Dimension of other main construction

a. Wire, spillway, syphone etc. apply correspondingly the above.

8. Construction cost of project

a. We cannot decide anything without economical consideration.

b. To compare the efficiency of dam we use Rp/m^3 for banking; Rp/m^3 for water storage.

c. Can you find out above unit cost easily from your cost table, exclude land cost, compensation cost, compensation work cost, appurtenant work cost.

How is your common construction cost table.

9. *Cost benefit ratio of project*

To get economical meaning of the geological or soil mechanic conditions, we must study them as partial factors constitute the project.

10. Beneficial area

Geological investigation is not only for design but also for project, then we cannot have any appropriate comments to others without following point of view.

a. Land use

Area size: Paddy, plant growing and other land use

b. Meteorogical data

Basic year for planning (return period)

Rainfall: Average rainfall, dry and wet season, continuous drought days.

Average yearly discharge.

c. Water requirement: Present and planned condition for preparation of paddy field, normal requirement, evaporation, percolation

d. Existing water resources and planned new resources (number and its volume)

River
Reservoir
Spring
Ground water
Rainfed

e. History of irrigation and present condition

Development of farmland, water utilization (transportation, living water, water power etc.) and flood control.

Record of civil engineering work.

EXTRACTION FROM "LAPORAN HASIL PENINJAUAN WADUK-WADUK KECIL DI-
KABUPATEN NGANJUK & TRENGGALEK, JAWA TIMUR"

Geological Memoir of Damsites

Sep. 10 - 17, 1974

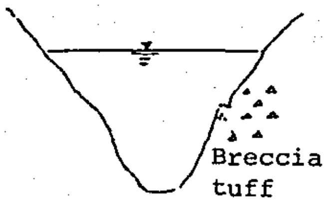
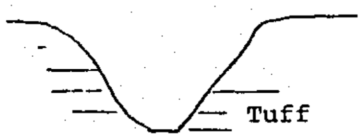
K. Uno

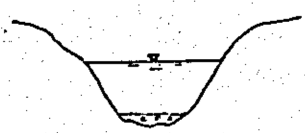
Sep. 18, 1974

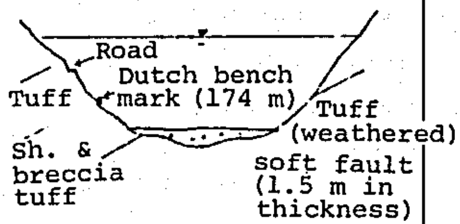
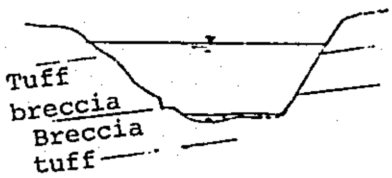
Existing relevant report:

Hydrogeology and land clasification (by U.K. team).

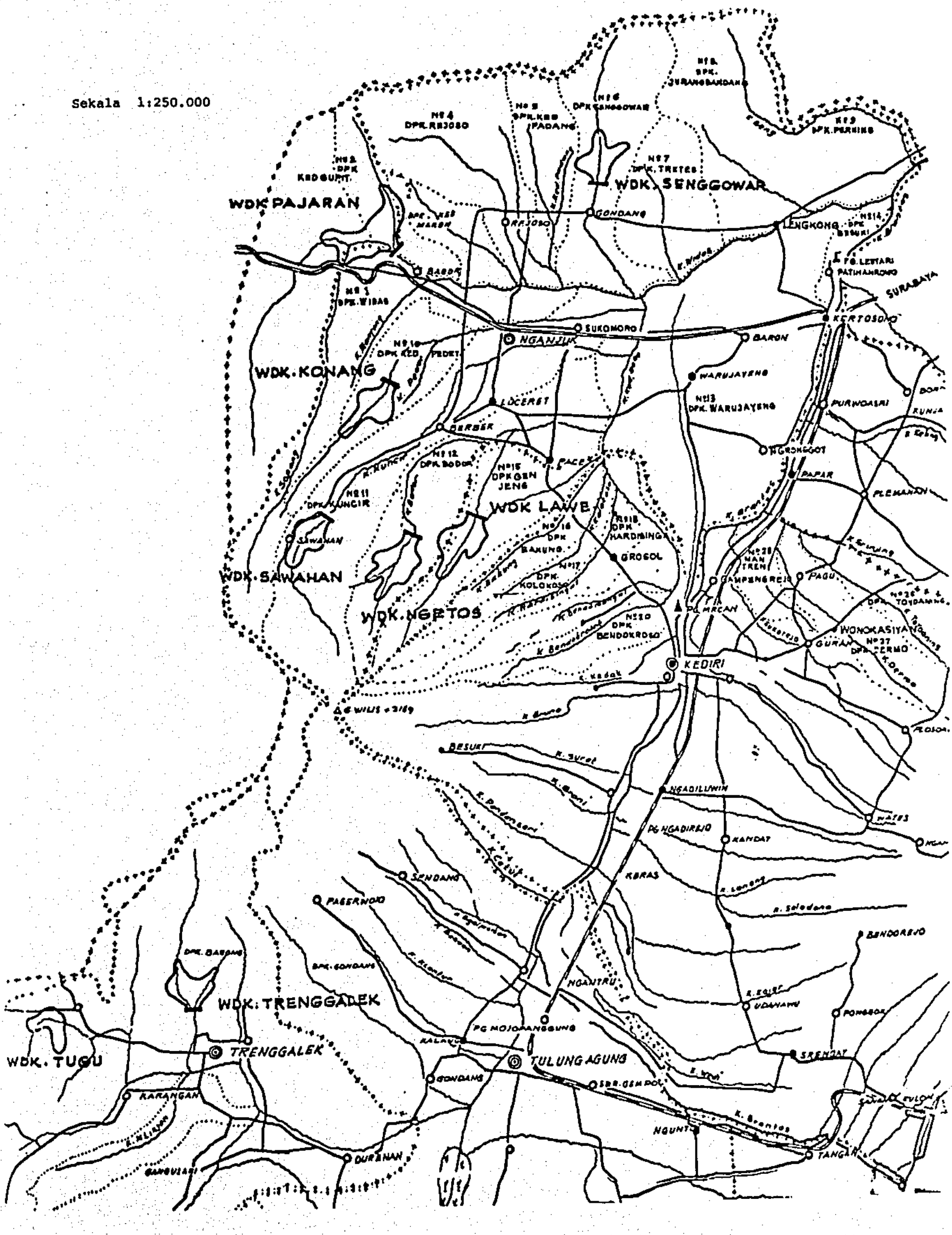
The Brantas river basin developing plan (by O.T.C.A. 1973).

Name and dimension	Geological condition	Point of issue	Superiority & note
Senggowar H = 20 m L = 110 m Benefit area = 500 ha (+1000 ha)	Tertiary & sh. etc. General trend N 30W 21S Down stream (first proposed site) white tuff, black marl, clay, white sh. about 10 m thickness 	1. Investigation for under laying rock. 2. Investigation for core & body materials 3. Relation between reservoir area & farmland in reservoir.	Fair Another small dam's plan (H = 5, L = 20 m) Precipitation 1800 mm, plantation of tobacco, partly ground water irrigation.
Konang H = 40 m L = 180 m Benefit area = 1000 ha (+1500 ha)	Tertiary? or Diluvium breccia tuff & tuff etc. Strata is almost horizontal. 	1. Permeability of rock. 2. Core & body materials.	Fair Small reservoir pocket of upper stream, teak forests and many pebble on top of both banks.

Name and dimension	Geological condition	Point of issue	Superiority & note
Sawahan H = 35 m L = 150 m Benefit area = 2000 ha (+1000 ha)	Diluvium, loose, reddish volcanic ash (including pebble or bolder). Seepage from bedding plane, lower part fairly hard? Water fall at left side.	1. Volume of sedimentation in reservoir. 2. Steepgradient of stream. 3. Existence of many springs around th the neighbourhood. 4. Required to examination of geology.	Fair With flood controle.
Ngetos H = 25 m L = 140 m Benefit area = 807 ha (+1000 ha)	Diluvium, loose reddish volcanics (breccia tuff). Many bolders on both abutment. 	1. Permeability of base rock. 2. Construction materials.	Barely fair Many pebbles at top of both banks, removal & cultivation are difficult.
Lawe H = 30 m L = 180 m Benefit area = 2000 ha	Same as above. 	1. Right abutment low. 2. Reservoir area and catchment area are too small. 3. Examination of damsite at Macianan (down stream).	Very poor Same as above

Name and dimension	Geological condition	Point of issue	Superiority & note
Tugu H = 50 m L = 800 - 1000 m Benefit area = 1784 ha (includes spring utilizing hilly area).	Tertiary. Tuff, breccia tuff, etc. Trend N 20E 14W N 40 - 70W 15W N 30W 10W 	1. Permeability of base rock. 2. Core, body material. 3. The depth of river deposit. 4. Fault.	Fair Small spring on sh. layer. Problem of farm-lands in reservoir. Already inspected by Nippon Koei Consultant.
Bagon H = 50 m L = 125 m W.V. = 35.000.000 m^3 Benefit area = 3300 ha	Tertiary. Same as above. Trend N 60W. 10S 	1. Permeability of base rock. 2. Core, body material. 3. Surveying.	Fair Existing geological report?

Sekala 1:250.000



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