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GEOLOGIC EXAMINATION OF THE GORGE
HIGH DAM SITE, SKAGIT PROJECT
SEATTLE CITY LIGHT

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Purpose

1. To give the general geological setting at the dam site.
2. To determine if the site has been adequately explored by drilling.
3. To recommend items in the specifications for excavation and construction of the dam.

Introduction

The writer spent one day at the dam site, March 19, 1954. Prior to this examination approximately 2 hours were spent at the site on September 14, 1953. During the course of the present examination Mr. C. Shevling and his staff placed all available information at the writer's disposal including drill logs and photographs of the drill cores, a model of the drill holes constructed by Mr. Hoidal, drawings and areal photographs. The writer has discussed the results of the drilling with Mr. John Nelson and Mr. William Irvin, drill inspectors.

To all of these persons for their wholehearted cooperation, the writer is most grateful.

Although the time spent at the Gorge site was brief the writer has been dealing with the problems of dam and powerhouse sites on this portion of the upper Skagit River for the past 12 years. Much of the experience gained from the work upstream is applicable to the Gorge high dam site.

General Geology

Bed Rock. The rock at the Gorge site and for many miles both upstream and downstream is a granite-gneiss. It is the only rock of any quantity in the entire area except for the river fill and rock fall material along the sides and bottom of the river.

The dam site is unusual in many respects. Most striking is the rise of solid bed rock up to the surface of the ground almost in the middle of the canyon and right at the edge of the river (see drill hole G. elev. 739.9 feet). In contrast the deeper and buried portions of the river channel lie on either side of this mid-channel dome. Toward the right bank

the bottom of the buried channel lies over 100 feet below the bed rock surface of the dome in mid-channel. The same situation prevails on the left bank where bed rock is over 100 feet below the dome surface and almost 200 feet below the surface of the ground at the foot of the cliffs.

The mid-channel dome will not only mean less excavation for the foundation of the dam but the buried channels on either side will provide an excellent situation for diversion during construction.

The granite-gneiss bed rock has many fault or slip planes as well as open joint planes showing in the canyon wall at the dam site. Drilling has shown that many faults and joints occur beneath the dam and in the abutments. One of the more extensive faults occurs below the dam dipping upstream and toward the right bank at an angle of approximately 28 degrees. The fault plane varies from a little less than 100 feet in depth at the axis of the dam to more than 100 feet upstream from the axis. At drill hole U there was almost four feet of sand in the fault zone approximately 115 feet below the surface. The fault zone may be checked by the logs of drill holes G, T, U, 38, 53 and 54.

In general it may be said that the bed rock above this fault plane is more broken than that below. However, the rock above the plane is by no means weak.

One of the most characteristic features of the upper Skagit river is the presence of huge blocks of granite-gneiss in the river bottom. All supposed bed rock outcrops in the river must be viewed with suspicion and drilled to determine whether they possibly could be loose blocks.

The dome of bed rock at drill hole G might have been such a block. however the drill penetrated 238 feet of rock. One of the best types of evidence indicating bed rock below the dam, rather than a series of fallen

blocks, is the presence and the uniformity of dip of the fault plane described above and encountered at several holes.

Other slip planes occur on the right bank and were encountered in drill holes O and OO. The planes are approximately 65 to 70 feet from the surface and roughly parallel the steep canyon wall at this point. The slip planes are characterized by about two feet of gummy sericitic material. Although these planes are small they are located in a rather critical zone where they thrust from the dam will transmit stresses into them at angles larger than right angles. A considerable mass of rock occurs outside the slip planes and it may well provide a stable thrust block. However, when stress analysis studies of the dam are made it may be well to review the rock situation on this right bank.

Buried channels Deep and rather narrow buried channels are rather typical of the upper Skagit River valley. They are filled with huge blocks and boulders of granite-gneiss along with finer sand and gravel. The extent and depth of the channels has been fairly well determined by drilling. However small slot-like and deep channels may be encountered during excavation that are not revealed by the present drilling. It may be necessary to emplace shafts of concrete above and below the dam if such slots are encountered.

The Drilling Program

Many holes were drilled in 1918-1919 and drilling was resumed again in 1953 and carried on into 1954. The writer had no part in laying out the drilling program except for a few of the more recent holes. The area is well covered with holes and the larger features such as the position of the buried channels and the central dome of bed rock are well established. The

design of the structure and cost estimates of excavation can be made from the subsurface data. Thus the preliminary drilling program seems complete.

I have recommended one additional hole between drill holes 24 and R and going in at 45 degrees from the horizontal under drill hole N. No vertical nor angle holes cross this critical zone where the thrust from the arch will be transmitted to the rocks in the abutment.

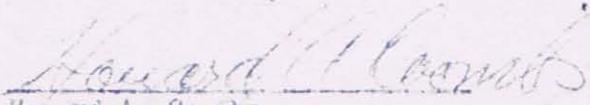
Recommendations

The writer suggests that some provision be made in the specifications for supplemental drilling on a limited scale during excavation.

It is also suggested that the site be examined geologically during excavation so that major joints and faults can be mapped in order to obtain information for the grouting program and possibly for further excavation.

Conclusions

1. Geologically the site is unusual in that bed rock rises in the central part of the valley bottom and is flanked on either side by buried channels over 100 feet below the bed rock dome in the center.
2. Fault planes and joint planes are numerous. One of the most critical is the fault plane approximately 100 feet below the dam and dipping upstream at an angle of 18 degrees. Other slip planes of importance are on the right bank and roughly parallel the steep canyon face.
3. The site has been adequately drilled to determine the design of the dam and to prepare cost estimates of excavation.


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