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Artikel: Korokuro-sawa steel-pipe grid dam, Yamagata (Japan)

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3. Korokuro-sawa Steel-Pipe Grid Dam, Yamagata (Japan)

Owner:	*Ministry of Construction*
Engineer:	*Kobe Steel, Ltd.*
Contractor:	*Kobe Steel, Ltd.*
Period of Construction:	*5 months*
Completion:	*December 1979*

Despite its small area the Japan archipelago abounds in mountaineous regions having plenty of precipitous mountains and steep valleys, which are subject to severe climatic conditions such as strong seasonal winds and typhoons. Various kinds of natural disaster, therefore, are not easily eliminated.

Debris flow is one of the most serious types of natural disaster in Japan and, historically, ceaseless efforts were made to prevent it.

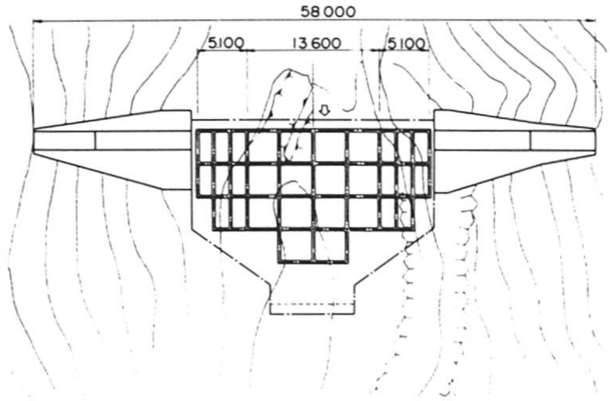
For years it has been very difficult to investigate the characteristics of debris flow, but now the phenomenon is better understood thaanks to the development of a suitable technology for its observation.

With this advance of technology the trend of debris flow prevention is changing from mere damming up the running debris into adjusting or controlling properly the sand and rock so as not to suppress the function of a river.

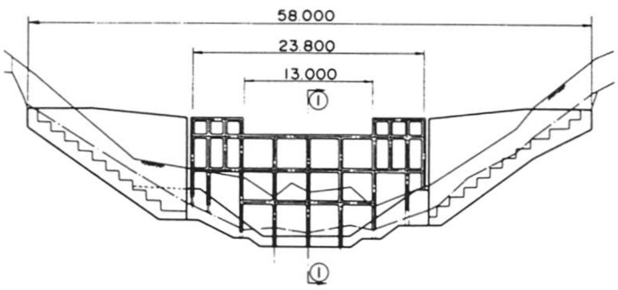
So far, most of the dams for debris flow prevention have been of the concrete gravity type. This type of dam shows an excellent performance in arresting the debris. Behind the dam, however, is filled up with rocks and sands immediately after experiencing a single debris flow of large scale, which means its life-span is rather short. Further, it lacks the function of supplying sand and gravel downstream, resulting in the lowering of the riverbed.

In recent years various kinds of debris-preventing structures based on new ideas have been developed. A steel-pipe grid dam is one of them and consists of large-sized steel pipes latticed in a three-dimensional form, which aims at arresting hazardous running rocks while at the same time adjusting the flow of sand and gravel effectively.

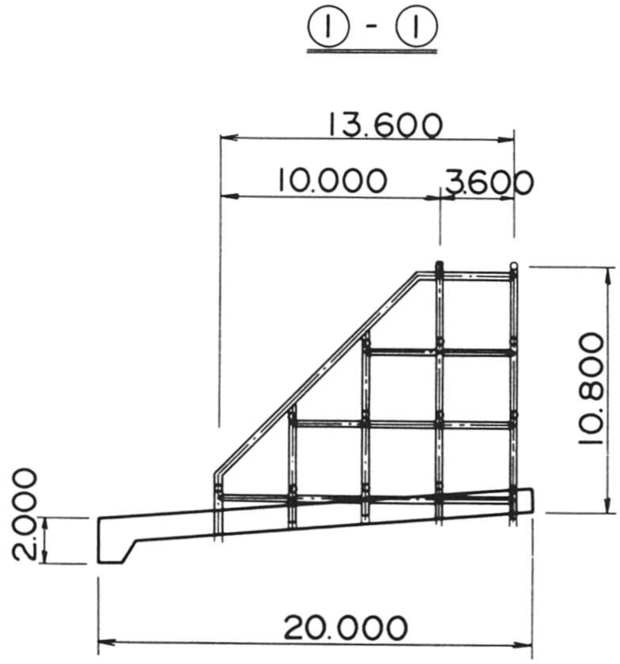
Korokuro-sawa Dam is Japan's first steel-pipe grid dam constructed in the mountaineous region of Mogami-gun, Yamagata Prefecture, in the northern part of Japan's main island Honshu. As is shown in the photograph and the illustration, the central part of the dam is a grid work of steel pipes and both sides are made of concrete. In August 1975 this region suffered big damage due to heavy rains followed by a large scale debris flow, in which a house was completely demolished and roads were covered with a large volume of rocks and sand. This disaster triggered the planning of dam construction for debris flow prevention and it was decided to erect a steel-pipe grid dam as the first trial in Japan after a detailed checkup as to its engineering performance and economic feasibility in comparison with the usual type of concrete dam.



Plan



Elevation



Section

In the following the performance of this type of dam is described:

1. Impact forces due to running rocks are absorbed effectively by the steel grid frame; large-diameter rocks are arrested and small ones pass through the grid with reduced velocity.
2. Though the dam front is heaped with sand and rock after a debris flow, sand and gravel are gradually washed away by the ordinary flow of water. The dam, therefore, fulfils its function as a preventive structure against debris flows.
3. According to observation, large-sized rocks have a tendency to collect at the front of a debris flow. Arresting only these large rocks suffices for the dam to prevent damage downstream, thus not exerting any harmful effect on the river.
4. The dam functions effectively even after experiencing several debris flows, which means the dam has a fairly long life-span.

External forces taken into consideration in the design of Korokuro-sawa dam are i) dynamic pressure due to debris flow, ii) impact forces due to rocks, iii) earth pressure due to accumulated sand, iv) hydrostatic pressure, v) hydrodynamic pressure, vi) seismic forces and vii) forces due to temperature change. Based on observations the maximum size of a rock is taken to be 1.5 m in diameter (average: 0.3 to 0.5 m). The design velocity of the debris flow is 5 m/sec and the weight of debris flow per unit volume is 2 tons/m^3.

To determine the size of the grid is an important item for the design. The result of a hydraulic experiment, which was conducted prior to the design, showed the value $b/d_{max} \doteqdot 2$ as the condition for restoring the sandstoring ability of the dam, where b is the grid interval and d_{max} is the maximum diameter of a running rock (hence, b = 3 m).

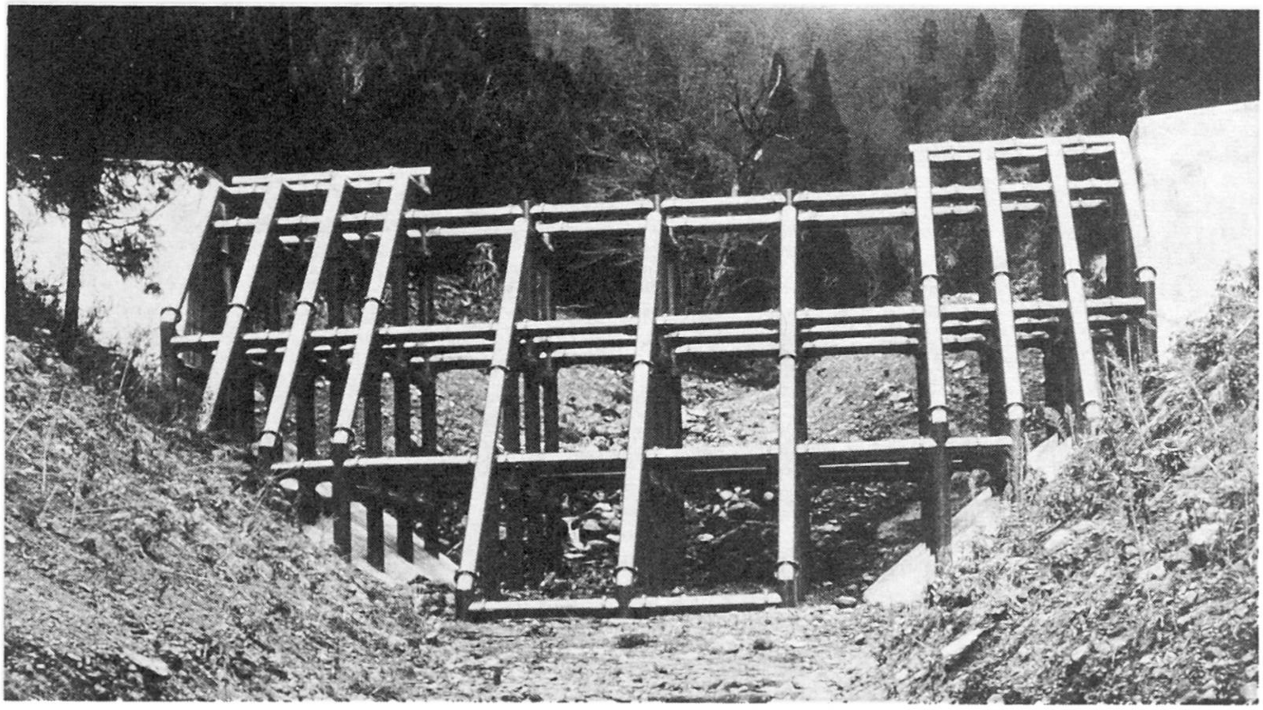
Cast steel pipe SCW50-CF and ordinary structural steel pipe STK41 were used for the grid work. Pipes for the grid have 406.5 mm / 355.6 mm diameter and 11.1 mm / 18.0 mm thickness, and pipes for the foot part have 406.4 mm diameter and 24 mm / 34 mm thickness. Each pipe wall is given an extra thickness of 3 to 5 mm against abrasion and corrosion.

Pipes are joined by high strength bolts F10T through 16 mm-thick flange plate. In the central part the feet of the pipes are fixed directly to bedrock by anchor bolts and at the side they are connected to the concrete foundation.

Design work was started in July 1975 and the whole construction was complete in December. The total steel weight is 149.2 tons, the total concrete volume is 1659.5 m^3 and the total construction cost was 123 million yens.

In the design of a steel-pipe grid dam the determination of grid size and the estimation of dynamic pressure of debris flow and impact force of rock are the very important items. The characeteristic of debris flow changes widely depending on the complicated conditions of climate, topography, etc. and general considerations are easily made. In the Ministry of Construction investigation into the hydraulic mechanism of the dam (movement of debris, rock-arresting capacity, hydrodynamic pressure, etc.) was made by using model structures installed in a experimental channel. Also, the ultimate strength of pipes was checked by a full-sized drop-weight test. It can be expected that these fundamental investigations become the most useful background for the future construction of steel-pipe grid dams.

(Yoshio Namita)



View of the Grid Dam