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JS-Wall Dam (Type INSEM) Using Sabo Soil-Cement†

1. Introduction

Sabo structures using steel materials are called steel sabo structures, and were developed and first introduced in various areas in the 1960s [1]. Subsequently, capture of debris flows, etc. was experienced with these sabo structures, contributing to sediment-related disaster prevention.

Steel sabo structures include gravity-type dams, and double-wall dams using steel frame, steel sheet piles, etc. Among these various types, double-wall dams use locally-generated earth and sand as the filling material. However, in addition to the recent issues of effective utilization of local earth and sand and reduction of greenhouse gases, double-wall dams using sabo soil-cement in the filling material have been commercialized from the viewpoint of improved economy in comparison with conventional dams using local filling materials, and the record of installation of such structures is increasing. Therefore, JFE Metal Products and Engineering developed the JS-Wall Dam (Type INSEM) (hereinafter "JS-Wall Dam") using sabo soil-cement in addition to types of dams using local filling materials.

2. Application of Soil-Cement in Sabo Field

The sabo soil-cement method is the general name for construction methods in which sabo structures are constructed by manufacturing sabo soil-cement by mixing cement or cement milk, etc. with locally-generated earth and sand. To date, four methods for effective utilization of locally-generated earth and sand have been developed, these being the "ISM method," "CSG method," "INSEM method," and "CSG method".

The INSEM construction method is used with "JS-Wall Dam" for the following reasons. (INSEM: in-situ stabilized excava materials; Sabo soil-cement which is manufactured by the INSEM method is called "INSEM material.")

One advantage of INSEM material is the fact that it is a super-hard kneaded material which is free of concrete slump. Moreover, because the same leveling and rolling compaction as with conventional double-wall dams are possible, general-purpose construction equipment can be used.

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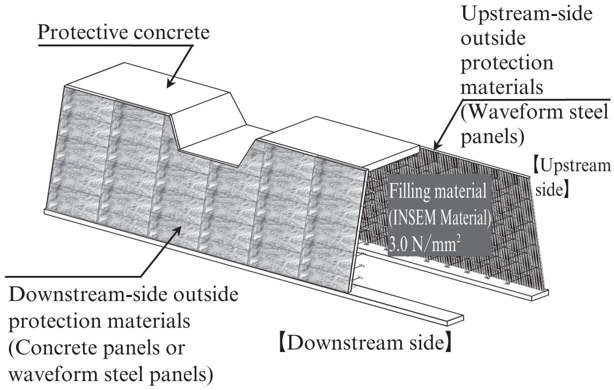

Fig. 1 Diagrammatical view

Since the filling material secures sufficient strength to resist internal stress in the dam, the dam can be studied as a rigid body, in the same way as concrete gravity-type dams. This means the dam cross section can be reduced. Accordingly, a more economical cross section is possible in comparison with conventional double-wall dams.

3. Outline of "JS-Wall Dam"

"JS-Wall Dam" is a gravity-type dam which comprises outside protection materials on the outer surface at the upstream and downstream sides and INSEM material as the filling material. A schematic diagram is shown in **Fig. 1**.

As the downstream-side outside protection material, a patterned concrete panel (reinforced concrete) with a combined landscaping function is used. The upstream-side outside protection material is a waveform steel panel of a steel material with a combination of high impact resistance against debris-flow loads and high covering capability.

The strength of the filling material is Desired strength level III (3.0 N/mm^2 or higher), which is required by the SABO Soil Cement Design and Construction Guidelines (Sabo and Landslide Technical Center) [2] as strength capable of resisting internal stress in dams.

4. Features of "JS-Wall Dam"

The features of "JS-Wall Dam" are as follows:

(1) Economy

Conventional double-wall dams have a parabolic edge section. However, with "JS-Wall Dam," it is

Photo 1　Assembling examination

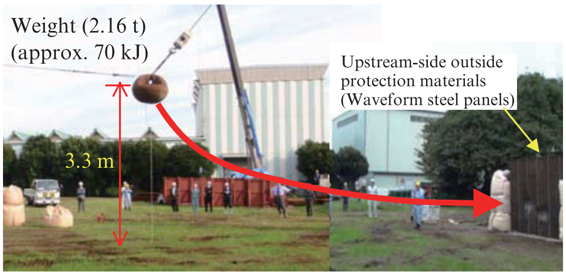

Photo 2　Experiment situation

Photo 3　Heteromorphic situation of outside protection materials

possible to reduce the cross section by adopting a straight slope in the wing section (part above the spillway section). Because this makes it possible to reduce the amount of construction of filling material in the dam as a whole, "JS-Wall Dam" offers superior economy.

(2) Workability

As the waveform steel panels are connected by bolts on four sides (top, bottom, right, and left), the panels cannot move or turn. Therefore, the waling that is required in conventional double-wall dams is not necessary. Because construction is possible using only the panels, workability is excellent.

(3) Prevention of Filling Material Exposure

Exposure of the filling material can be prevented, even in case of impact by stones, because the waveform steel panels are connected by bolts on four sides.

5. Verification of Functions

5.1 Assembly Examination

An assembly examination of the upstream- and downstream-side outer protection materials was conducted, demonstrating that assembly can be performed smoothly and with good accuracy. **Photo 1** is a view of the assembly examination, showing placement of a downstream-side concrete panel.

Trial construction of the filling material was also carried out at the same time. Leveling and tamping (compaction) work could be performed without problems in the areas around the outside protection materials, and the results satisfied the target values for both strength and density.

5.2 Performance Confirmation Test

Debris-flow load (stone impact load) acts on the upstream-side outside protection materials. Therefore, high impact resistance and high covering capability are required. An actual-scale test was carried out in order to confirm that the material satisfies these requirements. Impact load was applied to the upstream-side outside protection materials, and the fact that the panels and their joints form a structure with a function of preventing exposure of the filling material was confirmed.

(1) Experimental Conditions

The scale of the debris flow (stone size and flow velocity) was set, and a weight resembling gravel was impacted on the outside protection materials, assuming that the impact energy of the weight represents the impact energy of stones. A view of this experiment is shown in **Photo 2**. Impact load was obtained by a method in which the weight (2.16 t) was suspended from a crane and the weight was lifted like a pendulum by another crane, and a method in which the weight was impacted against the specimen by free fall, in which the weight was dropped on the specimen from a specified height (approximately 70 kJ).

(2) Experimental Results

The deformed condition of the outside protection materials is shown in **Photo 3**. From the deformed condition, it was confirmed that no cracks, separation, or similar damage of the upstream-side outside protection materials or their joints occurred and the filling material was not exposed under the assumed impact load.

6. Conclusion

This product received construction technology review and certification (Sabo technology) [3] in June

2011. Sales began in August of the same year, and orders have also been received.

In the future, JFE Metal Products and Engineering plans to make further improvements to increase workability and safety, and hopes to play a key role in sediment-related disaster prevention.

References

1) Ssbo and Landslide Technical Centersteel. Sabo structure design and construction handbook. 2009.
2) Ssbo and Landslide Technical Centersteel. Sabo soil cement design and construction handbook. 2011.
3) Ssbo and Landslide Technical Centersteel. Construction technology review and certification (Sabo technology) report. JS-Wall Dam (Type INSEM).

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