Concept of Setting Volume of Sediment Supply in Considering Channel Restoration in the Akatani River

SUWA Yoshio, Head, EJIRI Yuzaburo, Guest Research Engineer

River Division, River Department

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1. Introduction

The 2017 Northern Kyushu Heavy Rain caused slope failures simultaneously in different places along the Akatani River, a branch river of the Chikugo River system, leading to clogging of the channel and flood, as well as damage to people and many houses (see Photo 1). In the Akatani River basin, there still remains a lot of unstable sediment on the slopes and in the streams, and even in the event of a relatively small flood, sediment discharge that could cause riverbed elevation may occur. We therefore organized the concepts of how to determine the volume of sediment supply in order to consider river channel restoration based on the sediment deposition in the Akatani River.

Photo 1 Sediment deposition in the Akatani River

2. Grain size of sediment clogging the channel of the Akatani River

Figure 1 shows the riverbed height profile and grain size composition of sediment clogging the channel before and after the disaster in the Akatani River and Otoishi River, a branch river in the upstream of which a large scale collapse occurred. It is known from the grain size composition of the lower layer, which is considered free from the effect of sediment movement / fine classification by normal flow after the flood, that main components of sediment clogging the channel are coarse sand (0.5-1 mm), which constitutes sand of weathered granite soil, very coarse sand (1-2 mm), and fine gravel (2-4 mm). In the upstream, coarse grains are found more in the grain size composition of the surface layer than that of the lower layer since the ratio of medium gravel (4-64 mm) and large gravel (64-256 mm) is higher than the lower layer. In the downstream, refined grains are found more since the ratio of coarse sand increased than the lower layer. It can be conjectured from that the re-migration and classification of sediment due to the small flow rate

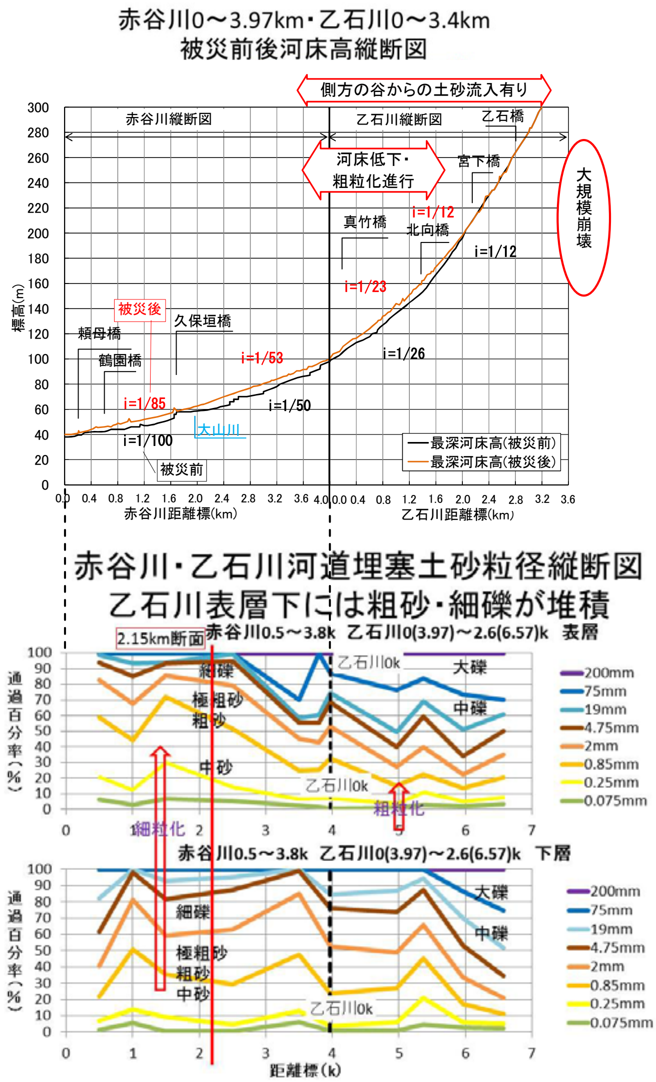

Fig. 1 Bed height profile (above) and grain size composition profile (below) before and after the disaster in the Akatani and Otoishi Rivers

after flood have begun to proceed.

Figure 2 shows the plotting of the grain sizes of riverbed material after disaster in the Akaishi and Otoishi Rivers on the map where relationship between the riverbed materials and grain sizes in Japan's Class A rivers is organized. In the Figure, dots representing the relationship between the grain size of riverbed materials and gradient in Japan's alluvial rivers gather near the line drawn from upper right to lower right on the graph. Riverbed materials are rather hard to move and stable when away upward from this line and rather easy to move and active when away downward.

Dots showing the riverbed materials of the Akatani River, etc. after disaster are away downward from the standard relationship in Japan's alluvial rivers, which shows that riverbed materials are in a condition where unstable sediment that is easy to migrate is deposited.

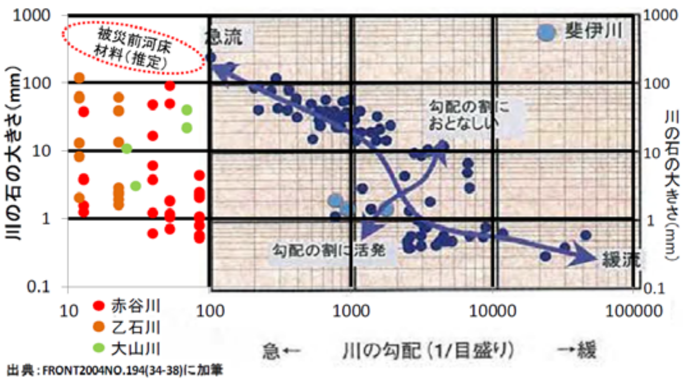

Fig. 2 Relationship between river gradient and river stone size

3. Setting the volume of sediment in design of channel restoration

In channel design, designed section is determined after verifying / forecasting riverbed elevation / degradation in the channel with riverbed variation calculation and confirming changes in the channel. In riverbed variation calculation, volume of sediment supply (relationship of sediment discharge Qs according to flow rate Q ("Q-Qs relationship")) is determined, and setting the volume of sediment supply based on actual status is important since the volume of sediment supply has a great effect on river-bed variation. Since volume of sediment supply varies according to deposition in the upstream and branch river, we studied channel design considering changes in the volume of sediment supply due to secular changes causing run-off / stabilization of unstable sediment in the upstream and branch river.

Figure 3 is a conceptual diagram assuming the Q-Qs relationship for each phase. Phase 1 is the volume of sediment supply before the disaster, Phase 2 is the volume of sediment supply when unstable sediment remaining after the disaster is moving actively, and Phase 4 is the volume of sediment supply when residual unstable sediment generated from the disaster is stable and is assumed to return to the same level in Phase 1. Note that Phase 3 is the volume of sediment supply in a transitional condition of returning from Phase 2 to Phase 4.

When setting the volume of sediment supply in design of channel restoration, Phase 2, where volume of sediment supply is large, was assumed as upper limit, and Phase 1 and 4, where volume of sediment supply is small, were assumed as lower limit. This is to ensure design for preventing revetments, dams, and groundsills from suffering damage due to riverbed degradation in Phases 1 and 4, where unstable sediment in torrents becomes stable. With setting of both upper and lower limits, river channels are designed to prevent rapid riverbed change and local riverbed elevation / degradation in either condition, and riverbed variation calculation is used for verification. Note that the Q-Qs relationship in the event of large-scale sediment generation is also important when considering disaster reduction measures, such as evacuation or land use.

4. Conclusion

Since deposition of run-off sediment is expected according to progress in development of erosion control dams and other facilities for restoration, it is considered important to continue to grasp the volume of unstable sediment in the upstream and scour / deposition in riverbed through sediment discharge observation and survey of riverbed materials and riverbed variation after flood season and to continue monitoring to secure discharge capacity

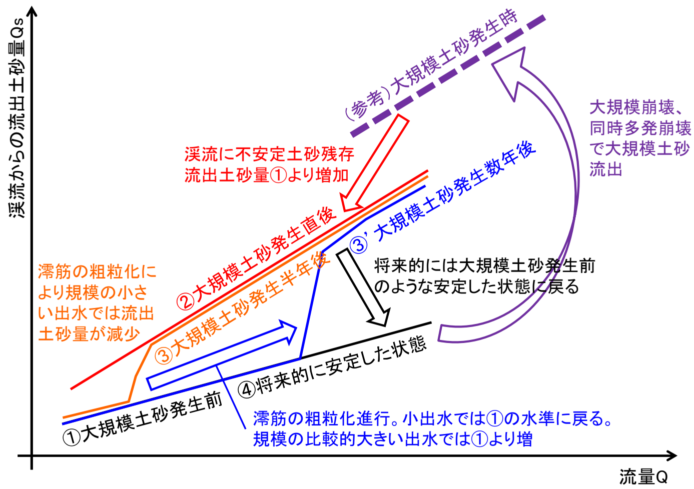

Fig. 3 Conceptual diagram for setting Q-Qs relationship in considering channel restoration

[References]

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