The Relationship between Seismic Characteristics and Large-scale Sediment Movement

Hiroaki SUGAWARA[1*], Atsuhiko KINOSHITA[2], Yasutaka TANAKA[1],
Tsuneshi NISHIOKA[3], Wataru SAKURAI[2], Gengo YOSHIMURA[1],
Soichi KAIHARA[4] and Noriko TADAKUMA[4]

[1] Sediment Disaster Prevention Technology Center, Kinki Regional Development Bureau ,Ministry of Land, Infrastructure, Transport and Tourism, Japan
[2] National Institute for land and Infrastructure Management, Ministry of Land, Inflastructure, Transport and Tourism, Japan
[3] Wakayama Sabo Research and Education Institute, Japan
[4] Eight-Japan Engineering Consultants Inc, Japan
[*]Corresponding author. E-mail: sugawara-h2c8@mlit.go.jp

INTRODUCTION

It is important to detect landslide dams formed by deep-seated landslides because these can cause enormous floods downstream. The detection of this type of large-scale sediment movement for risk management is possible using a network of sensitive seismic stations. In this study, we examined the relationship between seismic characteristics and the type of sediment movement to improve the detection of large-scale sediment movement.

ANALYSIS TARGET

The target of this seismic analysis was 46 large-scale sediment movements that occurred after installation of the High Sensitivity Seismograph Network Japan (NIED, Hi-net) in 2004. We categorized the 46 cases of sediment movement according to (1) whether a landslide dam formed and (2) whether the landslide collided with the opposite slope in consideration of the ratio of the sediment movement distance and collapse width.

SEISMIC ANALYSIS METHOD

When a large-scale sediment movement occurs, it is sometimes impossible to detect seismic waves caused by sediment movement if the seismic amplitude is small. We classified the seismic waves caused by sediment movement using two amplitude indexes: the 2- and 60-s root mean square (RMS) averages of amplitude, referred to as the short (STA) and long (LTA) time averages, respectively. For seismic waves produced by large-scale sediment movement, the STA was more than twice the LTA. We also investigated the dominant seismic frequency, degree of amplitude increase, and duration of the seismic wave of the detected event.

RELATIONSHIP BETWEEN THE FORMATION OF LANDSLIDE DAMS AND THE SEDIMENT MOVEMENT AND SEISMIC CHARACTERISTICS

There was no relationship between a steep rise in the gradient and the sediment movement type for long movement distances. Here, the sediment movement distance means the length from the center of slope failure to the front of the sediment. When the slided soil collides with the opposite slope with high impact force, the gradient should be steep (1 μ kine/sec or more) (**Fig. 1**). The amplitude of the seismic wave increased gradually in the case of the Akadani re-slide in 2014, when the landslide sediment reached the riverbed. The amplitude of the seismic wave meets the first peak of the seismic wave, when the sediment collided with the opposite slope, as in another study.

We postulated that the sediment movement itself increases the amplitude of the seismic wave when the sediment does not collide with the opposite slope, as in the case of long-distance sediment movement. Additionally, for long-distance sediment movement, we expected the amplitude to increase slowly because the impact strength is small.

Regarding the duration of the seismic wave, most of the landslide dams formed when the duration was 60 s or less (**Fig. 2**), although some formed when the duration exceeded 120 s with long-distance movement. This suggests that the distance the collapsed soil moves influences the seismic duration.

Considering the relationship among the dominant frequency, landslide dam formation, and sediment movement type, there were many cases in which a landslide dam formed when the dominant frequency was a low frequency, 0.5–1 Hz or 1–2 Hz (**Fig. 3**). In comparison, no landslides formed when the dominant frequency was ≥4 Hz.

REFERENCES

1) Takahara T., Kinoshita A., Mizuno H., Hasegawa M., Umeda H., Kaihara S., Asahara H.(2016) : A Study on Timing of Sediment Transport Phenomena Occurrence and Sediment Transport Process Using Seismometer Data, Advances in River Engineering, JSCE, Vol.22, pp.43-48

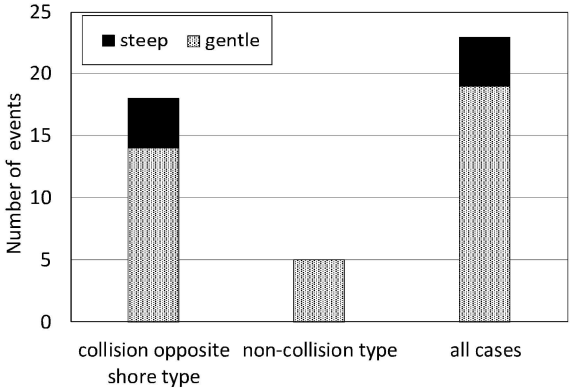

Fig.1 Relation between sediment movement type and seismic amplitude gradient

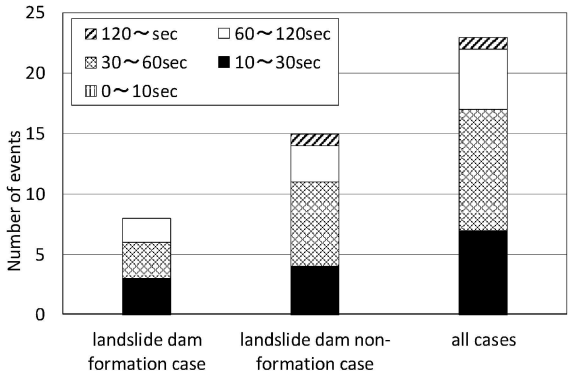

Fig.2 Relation between landslide formation and seismic duration

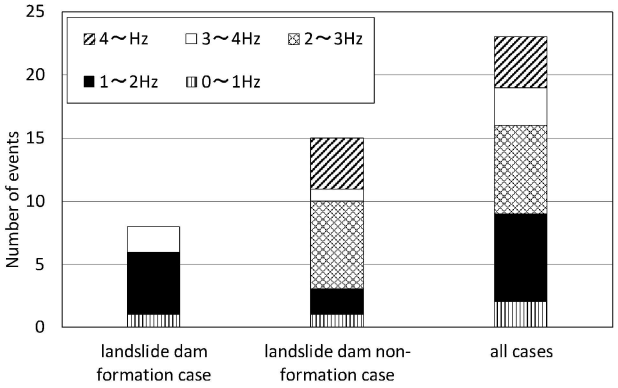

Fig.3 Relation between landslide and dominant frequency

Keywords: large scale sediment movement, Seismic wave