REDUCTION OF SAND PRESSURE TO THE PARTITION WALL USING LOGS IN FISH LADDER

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ABSTRACT: As a method to remove a large amount of sand away from fish ladder by small labor power, the authors have discussed the method to flush sand by water flow after the taking off the logs as partition walls. This method gives some good results in the flow experiments using a small fish ladder model. However, it is not easy to take the logs off the fish ladder because the sand pressure acts on the logs. This study is to show a new method to decrease the sand pressure on removing logs. A full scale model of fish ladder were made from timber, and removing log tests under the sand pressure were carried out in the field. As a result of the tests, the force of taking off the logs became 50 [kgf] per one log, which meant that the sand pressure were decreased. The application of this new partition wall to the fish ladder will bring easy maintenance.

KEYWORDS: Fish ladder, Log, Partition wall, Sand pressure

1 INTRODUCTION

There are large amounts of fish ladders in Japan at present. They are constructed beside the dam for fish to move upstream or downstream. However, most of them cannot function well as a way of fish because water flow is not in good condition due to sand, gravel, branches, etc. in the fish ladder. Some fish ladders have no water flow because of a great deal of sand.

To remove the accumulated sand in the fish ladder, the authors developed a new type of fish ladder which has log partition walls, and carried out the flow experiments[1]. As a result of the experiment, water flow can flush the accumulated sand after pulling up the logs used as partition wall. This result shows that the maintenance job does not need a hard work to remove sand. However, it was found that the work of pulling up the logs was not easy because of sand pressure to the logs.

In this study, a new type to fix the logs to the side walls of fish ladder is presented to reduce the sand pressure. The work of pulling up the logs in the human power is examined by the full scale model experiment. The result of this study leads to extended use of wood for the field of infrastructure construction, while almost all fish ladders are made of concrete at present.

2 FULL SCALE MODEL OF FISH LADDER

A full scale model of fish ladder, 1500mm wide and 2500mm long, was made by plywood for floor and side wall and by logs for partition wall, as shown in Photo 1. Floor slope has 10-degree gradient. The diameter and the length of the log are 200mm and 1500mm, respectively. Steel members are bolted to the side wall to put logs in, as in the right photo in Photo 1. In this study, water flow experiments were not carried out, but pulling up logs experiments were carried out, subjected to sand pressure horizontally.

Photo 1: Full scale model of fish ladder
This study discusses three types as fixing steel members to the side wall. In the first type, the steel member is fixed by upper and lower bolts, and it cannot slide. The second type can slide only at the upper bolt, and the third type can slide at both upper and lower bolts as shown in Figure 1. If the steel member is slid, space is made between the steel member and the logs. Since the logs can move horizontally due to this space, the sand pressure acting on the logs decreases.

![Figure 1: Fixing types of steel members](image)

### 3 EXPERIMENT OF PULLING UP LOGS

#### 3.1 OUTLINE OF THE EXPERIMENT

Under the sand pressure, the logs are pulled up by two ropes hung at the both ends of the log, and pulling up loads are measured by digital weight scale. Experimental conditions are as the following.

1. Fixing types of steel member: Type 1, 2 and 3.
2. Moisture content of sand: little (6.4%) and much. (saturated)
3. Height of accumulated sand: 10, 20 and 30 [cm].

#### 3.2 RESULTS OF THE EXPERIMENT

Photo 2 shows the condition of Type 3 just before pulling up and right after sliding the steel member. As soon as sliding, the logs move for the direction of sand pressure. The sand pressure acting on the logs, at this time, is reduced.

Figure 2 shows the pulling up loads of one log measured by digital weight scales. When the height of the accumulated sand is zero, that is, no sand pressure, the pulling up load is 20 kgf in all types. This is the same as a dead load of one log. On the other hand, when the height of the accumulated sand is 30cm, the pulling up load is over 80kgf because of sand pressure in Type 1 and 2. It is difficult for even two workers to pull up the log with this weight. However, in Type 3, the pulling up load is 50kgf at the 30cm height of sand, which means that it is easy for two workers to pull up one log, since one worker only pull up 25kgf.

![Figure 2: Loads of pulling up a log](image)

### 4 CONCLUSIONS

Conclusions of this experimental study are summarized as follows.

1. Fixing mechanism of logs to side walls originated, and the labor-saving of pulling up a log was examined.
2. Type 3 is the most effective in reducing sand pressure to logs.
3. It is possible for two workers to pull up a log because the pulling up load per one worker is only 25kgf.

### REFERENCES