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European Working Group "Management of dam incidents" Case study: Finland

Mr. Juha Laasonen
Fortum Power & Heat Oy, Power Solutions, Finland)
juha.laasonen@fortum.com

ABSTRACT

European ICOLD Working Group "Management of Dam Incidents" was established in Venice Italy in April 2013 to study European dam safety practices and experiences. The study will comprise at least following items: the dam safety legislation, the guidelines and the documentation related to the dam incidents, the training activities of dam incidents, the roles of the authorities and the dam owner, the safety arrangements practices and the analysis of the dam incidents and failures. The management of the dam safety at the tailings dams is included in the scope. The objectives of the Working Group are to improve the practices handling dam incidents and to collect the best practices of the member countries. In this paper the work on Finnish ICOLD committee are presented by introducing some characteristics of Finnish dam safety legislation and experiences.

Keywords: dam safety, management, legislation, dam incidents.

1. INTRODUCTION

The dam owner's responsibility is to ensure safety in the construction, maintenance and operation of a dam and reduce the hazard and the consequences, which the dam incident or accident may cause. The dam is monitored and inspected in order to detect changes or abnormal operation. The upgrading or the repair of the dam is carried out to avoid any dam accidents or incidents. However the changes in the dam condition may occur instantly and without warning. The dam owner shall start emergency repair. The alarming, evacuations and rescue operations shall be initiated, if the situation is critical (**Figure 1**).

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Although best European dam safety practices for managing dam incidents are collected. The objectives is also to improve national dam safety practices. FINCOLD has established

a national working group to collect and analyze Finnish experiences. In this paper is described some Finnish dam safety practices and experiences. The paper includes the issues on Finnish dam safety legislation, practices on emergency preparedness plans and training of rescue actions also some dam safety incidents are presented.

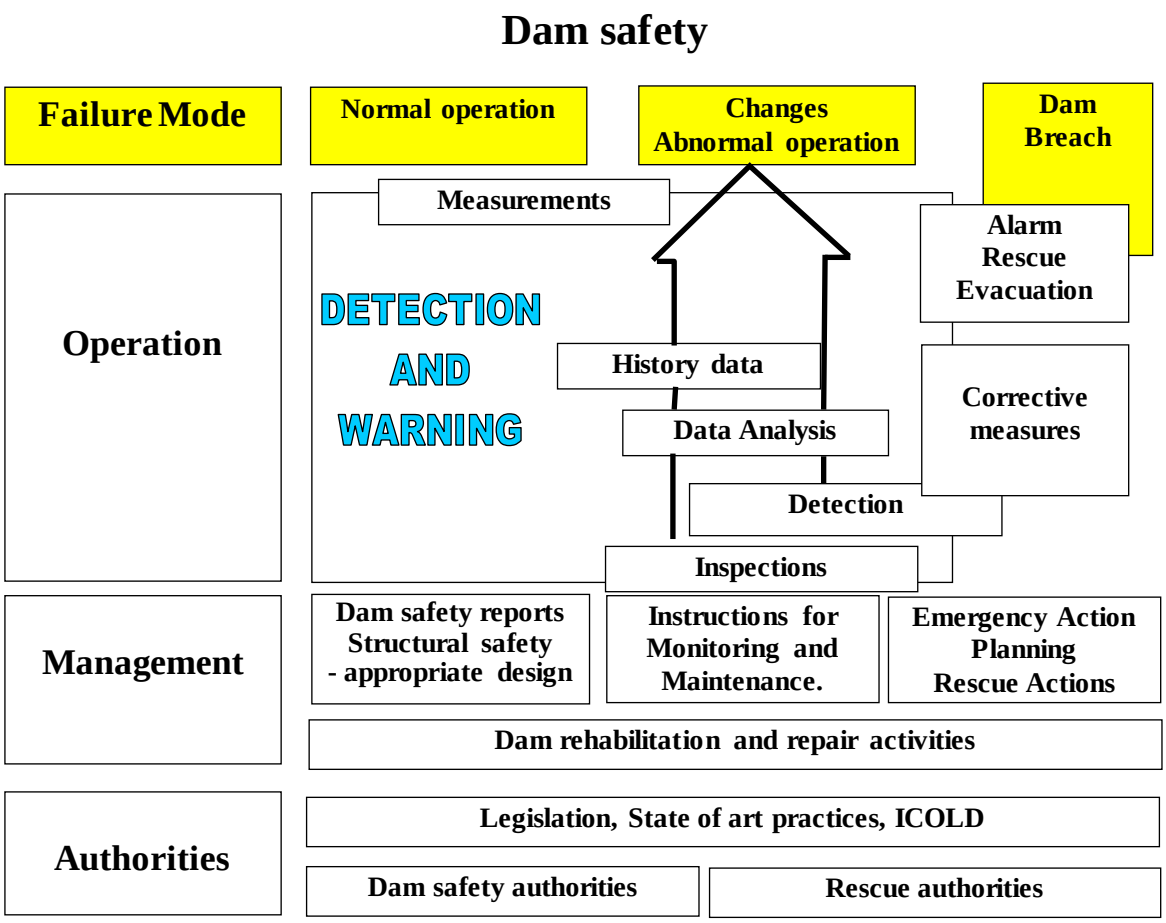

Figure 1. Dam safety activities and players

2. FINNISH DAM SAFETY LEGISLATION RELATED TO MANAGEMENT OF DAM INCIDENTS

Finnish dam safety legislation was enacted in 1984. The dam safety legislation was presented in the act, the decree and the guidelines. However the dam safety practices described in the guidelines had not any legislative ground. Therefore Finnish dam safety legislation was renewed and the practices were included in the Dam Safety Act (429/2009) and in Government Decree on Dam Safety (319/2010). In addition the renewed dam safety legislation are applied to the tailings dams.

The dam break hazard analysis and the dam owner's emergency action plan have to prepared for the high consequence class dams (class 1-dam) (Section 12 in Dam Safety Act (429/2009). The dam hazard analysis is further described in Section 6 of Government Decree on Dam Safety (319/2010) and it contains dam break flood wave analysis, the determination of the maximum coverage of dam break flood flow (flood hazard area), identification of the objects (people at risk, private and communal houses, industry, etc.)

in the flood hazard area and an estimation of the damages. The information and the documentation of the dam break hazard analysis are used in the preparation of the emergency action plan and rescue service plan.

The measures to prevent personal accidents in case of dam incident and to prevent and to limit the damages at the dam are presented in dam owner's emergency action plan (Section 7 in Government Decree on Dam Safety (319/2010). The measures shall protect humans, property and environment against damage. The dam owner shall alarm and report the dam incident. The plan is developed based on the dam failure scenarios and their possible hazard. The dam owner's organization and responsible persons with contact information are included. Possible ways to receiving information on the dam incident or hazard and the alarming of the authorities, personnel and people are described. The dam repair materials and its storage, the contractors and their equipment and own staff are listed with contact information. The document shall continuously updated.

Specific technical requirement for class 1 and 2 dams is that the crest throughout its length must be passable to traffic (Section 4 and 5 in Government Decree on Dam Safety (319/2010). The access of the dam maintenance must be ensured during the flood and dam accidents.

Dam Safety Act (494/2009) comprises 7 chapters and "the preparations for the accidents and actions in the event of accidents" are described in the Chapter 5. The dam owner with due consideration of the dam hazard must take the necessary action to prevent dam accident and to limit the damages caused by an accident (Section 24: Preventing accidents). The dam safety authority submits the information in its possession necessary for preparing the rescue service plans as requested by the rescue authority (Section 25: Rescue Service Plans). Provisions on rescue activity are laid down in the Rescue Act. The owner of a dam and dam safety authority must assist the head of the rescue activity in performing rescue activity. In addition, the dam safety authority participates, where necessary, in the work of the steering group (Section 26: Rescue activity). The declaration of an emergency and an exceptional situation are described in Section 27. It also states that the dam owner must notify the dam safety authority without delay.

3. RESCUE SERVICE PLANS AND TRAINING OF RESCUE ACTIONS

The operations of the rescue authorities are guide by Rescue Act (379/2011). The officer in charge of the rescue operation has the overall charge and is responsible for maintaining the situation picture and for coordinating the operations (Section 35: Command of rescue operations in situations involving co-operation). External emergency plans are prepared for the waste sites for extractive waste referred to in section 45a(2) of the Environmental Protection Act (86/2000) (Section 48: External emergency plans for sites posing a particular hazard), which may be applied some tailings dams with hazardous chemical content.

The training on the rescue actions based on dam break flood analysis has become a practice in Finland. First exercise was held in Rescdam-project in 2001 (Finnish Environment Institute, 2001). The dam breach situation of Kyrkösjärvi embankment dam was simulated in the exercise. The rescue and dam safety authorities were responsible for the execution. The objectives of the exercise was to test and improve: the emergency

action plan, the alarming system and its coverage area, the operation of different parties in the crisis management center, the co-operation of the authorities and the volunteers, the leadership of the regional rescue operations, the intercommunications and the communication during the dam breach accidents.

Second exercise was held in 2006. The dam breach of Seitakorva embankment dam in Northern Finland was simulated in the exercise. Third dam exercise will be held in 2014.

4. DAM INCIDENTS IN FINLAND

The dam owner is responsible to give notice concerning an exceptional situation (dam incident) to the dam safety authority without delay (Section 27 in Dam Safety Act 494/2009). The dam safety authority is collecting the dam incident reports and some preliminary analysis has been carried out (Kirves, 2010).

The earth fill dams with glacial till has had problems with internal erosion in Finland. Several cases with increased leakages, sink holes and turbid water has occurred.

The springs at Peltokoski embankment dam appeared during the first fill of the reservoir in 1950's and second one in 1980's. In late winter 1987 the spring collapsed approx. 60 meters from the left embankment dam. A large sink hole of 3 meter deep and a settlement of 29 cm at the dam crest were formed (**Figure 2**). The collapsed bank was repaired by constructing inverse filter with stones on the surface and with grouting of the embankment. Two Thompson overflow weir were constructed behind the inverse filter. Total leakage was 35 l/s. The water was clear without any sediment suspension. Main reason for the internal erosion was the leakages through the fissured bedrock (Laasonen, 2010).

Figure 2. A large sink hole appeared at the place of spring in 1987 (Laasonen, 2010)

Uljua homogeneous earth fill dam is situated in the River Siikajoki watercourse. The leakage was noticed during the first filling in 1970, which was turbid after one month. The

embankment dam was repaired with cement grouting. The cause was estimated as possible frost action in the upper part of the moraine core (glacial till) and deficiencies in the fine filter. Further a turbid water was found in the tailrace channel in 1990. Several sink holes of 3 meter diameter was found at the bottom of the reservoir. The leakage through the fissured bedrock was considered as the cause.

Melo embankment dam is situated in the River Kokemäenjoki. The leakage and a sink hole with the depth of 3.5 meters and a diameter of about 4 meters was noticed in 2005. The leakage was repaired with sheet piling and with grouting. The repair activities lasted 10 months. The cause for the internal erosion is considered the differential settlement of the core at the cast-in-pile, which was considered under the core.

Pamilo embankment dam in the eastern part of Finland has had several dam incidents. first one during the first filling and the latest sink holes appeared in 2008 and 2012. The sink holes were filled and emergency grouting was carried out. Several causes for the internal erosion have been considered improper construction of the core (the frosted moraine core was not removed), the deficiencies of the filter and the leakages through the fissured bedrock.

The emergency grouting were carried out in all the cases. In addition extensive site investigations were started in order to find out the cause of the internal erosion (Figure 3).

Figure 3. The site investigations at Pamilo embankment dam.

The causes of the internal erosion have been the deficiencies with the filter, insufficient filter coverage between the ground moraine and the embankment dam, frost action in the core, the differential settlements of the moraine core due to the partial sheet piling and fissured bedrock under the moraine.

6. CONCLUSIONS

The work on European ICOLD Working Group "Management of Dam Incidents" has started. Some characteristics of Finnish dam safety legislation and experiences are presented in this paper. It requires more detailed analysis of the case studies i.e. how the emergency cases were handled. The internal erosion cases presented in here show one type of the dam incidents. Several other hazards and uncertainties e.g. malfunction of the mechanical and electrical equipment of the gates can lead to a dam incident. The management of dam incidents requires comprehensive understanding of the dam risks and its mitigation measures. Each dam is an individual structure with specific features. However the "Management of dam incident"-study may improve dam owner's understanding and give tools to handle the abnormal situation.

The questionnaire is prepared for collection of European practices and experiences. The preparation of the conclusions requires discussions in the workshops to understand different aspects and opinions.

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