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newsletter

Tailing dams

Dam failures may potentially lead to major loss events with disastrous consequences for humans and the environment. Tailing dams are particularly prone to developing problems. These are dams used for storing industrial waste such as residue from mining operations. A case in point is the recent failure of the tailing dam of a Hungarian aluminium plant. The liability issues relevant to this case are discussed below.

Recent loss event

Following heavy downpours the dam of the red sludge reservoir of a Hungarian aluminium plant ruptured on 4 October 2010 ("the Kolontár dam failure"). Red sludge is a by-product of aluminium production and mainly consists of alkaline ferrous hydroxide blended with other less acutely toxic metal alloys such as titanium, silica and aluminium compounds.
The rupture released a torrent of approximately one million cubic metres of sludge which then merged with a river, partially flooding the villages in the vicinity. Nine people died and over 150 others suffered injuries in the flood which also destroyed or heavily damaged more than 300 homes and devastated an estimated 40 square kilometres of surrounding land. Whether the villagers will ever be able to return to their homes is in doubt; similarly, the exact toll on animal and plant life remains unknown. The long-term consequences in particular are difficult to estimate. The cleanup costs alone are expected to run into the tens of millions of euros.

Cause

What caused the dam to rupture is as yet unknown as reliable information remains elusive. The company in question has been put under government supervision and the individuals at fault have since been arrested, while a state of emergency has been declared in the flooded areas. The plant was able to resume production after two and a half weeks but has been dumping the new red sludge into a different pond.

Tailing dams

Most tailing dams are reservoirs built for storing the leach residue (tailings) accumulating in large quantities in ore milling processes. Such (mostly aqueous) reservoirs are used also by chemical companies to store process chemicals whereas power plant operators use them to deposit residual ash. Substances typically found in such dumps include (heavy) metal salts, slag, ash, sand or hydrocarbons and the like. While some of these substances may be harmless, others can be highly toxic (such as cyanide) or radioactive. Tailing dams vary dramatically in size. Today's largest is the Syncrude Tailing Dam in Canada where residue from oil sands exploration is deposited. At present the dam is up to 90 metres in height and stores close to one million cubic metres of waste water.
Worldwide there are some 3 500 tailing dams of any significant size, along with about 80 000 conventional dams. All tailing dam designs fall into one of three types – upstream, downstream or centreline – which work according to different principles. For a description, discussion and comparison of all three, please refer to the literature, such as http://www.wise-uranium.org/mdap.html.

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Tailing dam versus conventional dams

Tailing dams differ significantly from conventional dams and barrages, which tend to be used to store water or control water levels or to generate electricity.
For example:

- It is typical for tailing dams to be subject to continual expansion over their operational life and accordingly for their (safety) requirements to keep changing along with them.
- Tailing dams are used mostly for dumping waste that is toxic, harmful to the environment or radioactive and any leakage of which (unlike water), no matter how minor, must be prevented therefore at all cost.
- Tailing dams are often constructed as mere earthfill dams (unlike dams made of concrete).
- Tailing dams are very costly to operate whereas the water stored in conventional dams is a valuable asset.
- Conventional dams have a limited lifespan whereas tailing dams must be maintained for considerably longer periods, often long after filling operations have ceased (over centuries, if necessary).
- Conventional dams are perceived as vital assets by most of the general public and minor incidents involving them tend to be better tolerated as a result. Tailing dams by contrast are seen primarily as hazardous liabilities.
- Tailing dams are frequently constructed by mining companies rather than specialised dam builders.

Dam failures and the frequency thereof

For numerous reasons, including the aforementioned, tailing dams are often built to lesser safety standards than conventional dams and as such tend to be more prone to incidents and even failure. In each of the past 30 years, for instance, as many as five serious accidents and no fewer than two failures involved tailing dams. Given about 3 500 major tailing dams operating in the world, the odds of any of these failing range between 1:700 and 1:1 750. Conventional dams meanwhile are ten to 50 times (1:10 000 – 1:50 000) less likely to fail. (Source: Tailsafe Report Tailings Management Facilities, Risks and Reliability, 2004; http://www.icold-cigb.net/).

Examples

Major tailing dam failures, 1998-2010

Year	Mine/disposal site	Cause	Description, consequences
2010 Kolontár, Hungary	Aluminium	(Currently) unknown	Nine dead, 150 injured, 300 homes destroyed, 40 km^2 area surrounding site directly hit
2000 Baia Mare, Romania	Gold	Heavy rains and melting snow	100 000 m^3 of highly toxic cyanide compound contaminate rivers, poison hundreds of tonnes of fish and pollute drinking water for two million people
1998 Los Frailes, Aznalcóllar, Spain	Zinc, lead, copper, silver	Dam failure due to shear failure	5 000 000 m^3 of toxic water/mud pollute a thousand hectares of arable land, affect some waters of Doñana National Park

Major tailing dam failures since 1900 are estimated to number 150 or more, 57 of which occurred in the US and 26 in Europe. More than half of all such failures involve tailing dams more than 15 metres in height, fewer than 25% of which exceed 30 metres; 85% of accidents occur in dams still in operation, with upstream-type designs the most prone to failure. (Source: Rico et al, Journal of Hazardous Materials 152 (2008), 846-852.)

Major causes of failure

In many cases, safety issues of tailing dams involve flawed design, substandard construction work and shortcomings in monitoring and maintenance or repairs. Ultimately, most triggers of dam failures are weather related, such as heavy rainfall, flooding and melting snow. Other causes include earthquakes, subsidence and other types of structural failure, often also occurring in combination.

Legislation and regulation

Tailing dams are governed by national legislation which may vary significantly from one jurisdiction to another. Often, these laws turn on the size or hazard potential of an operation. In addition there are a number of organisations such as the International Commission on Large Dams (ICOLD) that provide recommendations and guidelines on safety requirements; see http://www.tailsafe.bam.de/pdf-documents/TAILSAFE_Legislation_and_Regulation.pdf.

Risk assessment

Technical assessments of third-party liability potential consider in particular detail a dam's design and method of construction, the type and volume of material it stores and – equally important – its exact physical location. As illustrated by the recent catastrophe in Hungary, the potential scale of losses can be significant. Geographical information systems (GIS) can prove valuable tools in analyses of location-specific risks. Important parameters for such analyses are the distances to residential areas, nature reserves and lakes and rivers.
Given the high frequency of dam failures specifically due to meteorological events and earthquakes, technical assessments should examine whether these were factored adequately into construction design and execution. Tailing dams have a very long operational life of up to several hundred years, which is why even the rarest of events such as once-in-a-century floods will be relevant for analysis.
Important criteria to cover in technical assessments are as follows:

- Dam: design and construction method, height, subsoil, filling material, age
- Natural hazards: floods, earthquakes
- Water control: seepage, overtopping
- Risk management: planning, inspections, maintenance, risk assessments

Information for the underwriter

Especially in the mining industry it is customary to dump large volumes of residue from ore milling into ponds built for this purpose. The recent accident in Hungary illustrates the serious consequences dam failures may have, especially if involving large spills of toxic and environmentally harmful substances. Liability underwriters are well-advised to be meticulous in assessing the exposure of tailing dams given the special risk profile and high inherent risk of such structures. Attention should be paid not only to acute hazards but also to cases of gradual contamination such as seepage.
In addition, underwriters should bear in mind that tailing dams are expanded continually throughout their operational life and that their risk profile may change accordingly over the same period.

Contact

AssTech GmbH
Postfach 1211
85766 Unterföhring bei München
Telephone + 49 89 3844-1585
Telefax + 49 89 3844-1586
info@asstech.com
www.asstech.com