



Hazard Risk Assessment

Dam Failure and Structural Collapse

Dam Failure
Structural Collapse – Buildings
Structural Collapse - Transportation

Dam Failure and Structural Collapse

The section covers both dam failure and structural collapse for buildings and for transportation bridges or overpasses. As you will see when completing the risk assessment both can be caused by nature and by people (human-caused). Resources are available to assist you in completing this assessment in the Risk Assessment Resources section.

Dam Failure^{1 2 3 4} - Natural and Human-caused

Definition

A dam breach is defined as a breach in the dam itself, its foundation, abutments, or spillway, which results in large or rapidly increasing, uncontrolled releases of water from the reservoir.

Don't forget that dams can be many kilometres away and still have an impact on your community if they fail.

Discussion

A dam breach threatens life and property downstream of the event. In many locations, roads, railways, bridges and ferry networks would also be at risk. Three general categories causes of dam failure are:

- static (caused by erosion, increased seepage, ice effects, terrorism);
- seismic; and
- hydrologic (flood-related).

In Canada, the most significant hydrologic dam failure is considered to be the Saguenay flood in 1996. Canada is particularly prone to dam failure hazards due to ice effects (fluctuations in water levels affecting ice loads) because of its northern orientation. Large dams in Canada have a median age of 40 years—approximately halfway to the estimated 75-year life span of an unmaintained dam⁵. Dams pose significant hazards in other ways besides complete failure such as the potential for massive landslides.

It Happened Here...

On June 13, 2010 a privately-owned earthen dam failed causing a debris and mud torrent that severely impacted homes and agriculture in the area, including Testalinden Creek, British Columbia (population unknown)⁶.

Between July 18-20, 1996 severe flooding in the Saquenay region of Quebec caused multiple dams to fail. Of the 280 municipalities in the region 63 were stuck by the flood and 16,000 people had to be evacuated. Ferland-et-Boilleau, Quebec (population 626) was among the many affected. There were no deaths or injuries linked directly to the dam failures. The estimated damage costs for the region was \$700M.

Dam Failure

Hazard Rating	High Risk <input type="checkbox"/>	Low Risk <input type="checkbox"/>	Need More Info <input type="checkbox"/>	Not Applicable <input type="checkbox"/>
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Yes	No	Need More Info	Not Applicable	FACTORS
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	**There is a risk if a dam is located upstream of a community. Does your community have a dam located upstream of it?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Improper dam maintenance increases risk. Is your community located near a dam that does not have adequate maintenance and safety records?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Dam failure can have a domino effect and cause dams downstream of the initial failure to also fail. Are there multiple dams located upstream from the dam in/near your community?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unusually high rain and/or flooding can cause a dam to fail. Is your community at risk for floods (refer to the section on Floods)?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Earthquakes can cause dam failure, especially in the case of earth dams. Are there earth dam upstream of your community that have not been seismically upgraded and is your community at risk of earthquakes (Refer to the section on Earthquakes)?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Landslides along the reservoir bank can cause dam failure. Are the banks around the dam at susceptible to landslides (Refer to the section on Landslides)?

Structural Collapse

Definition

The loss of structural integrity of a building or bridge that results in significant personal injury, death, or imposing major economic loss. Structural collapse occurs when a building or structure collapses due to engineering or construction problems, metal fatigue, or as a result of changes to the load bearing capacity of the structure.

Discussion

Buildings collapse from other causes besides earthquakes, but they are one of the prime hazards which cause structural failure. When buildings collapse they invariably cause ruptures in existing infrastructure such as gas lines, electricity, water, sewerage and telephone lines, and fires often result from structural failure. The primary areas of concern in the province are those buildings which are old, have not been maintained and which accommodate a large number of people. Although engineering standards are high, human error can always occur and thus structural collapse of a major structure potentially exists in many areas.

As well, structural failure can occur in bridges, highway overpasses, silos, reservoirs, tanks and towers. Usually failures in these types of structures are as a result of poor maintenance or engineering error.

It Happened Here...

In 2005, The Archie Simpson Arena roof collapsed at about 6 p.m. on a Sunday, closing down the 22-year-old structure indefinitely. Fortunately no one was injured - Fort Chipewyan is one of Alberta's oldest established communities and is located about 280 kilometres north of Fort McMurray and is accessible only by boat, air and winter road.⁷

On March 1, 2011 in Lebret, Saskatchewan (population 203) part of the roof of the community's arena collapsed during a hockey game and involved an area of the rink that wasn't being used. The weight of snow on the roof is being blamed.⁸

Structural Collapse – Buildings ^{9 10} -- Natural and Human-caused

All public buildings built prior to the adoption of the Canadian National Building Code should be properly inspected by a structural engineer.

Hazard Rating	High Risk <input type="checkbox"/>	Low Risk <input type="checkbox"/>	Need More Info <input type="checkbox"/>	Not Applicable <input type="checkbox"/>
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Yes	No	Need More Info	Not Applicable	FACTORS
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Building codes have been developed to ensure that structures are well built and safe. Have new and past construction projects been built without being regularly inspected and/or have building standards not been regularly enforced?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	**Are there unreinforced masonry buildings in your community and is your community at risk of earthquakes? (Refer to the section on Earthquakes)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	**Are there unreinforced masonry buildings in your community sitting on liquefiable soils and is your community at risk of earthquakes? (Refer to the section on Earthquakes)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Buildings and other infrastructure may decay over time. Have buildings been allowed to exist without regular inspections and repairs over time?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there public buildings such as schools, arenas or auditoriums which have been built before the adoption of the National Building Code and which have not been recently inspected by a structural engineer and where large numbers of people may gather at one time?

Structural Collapse – Transportation¹¹ - Natural and Human-caused

Hazard Rating	High Risk <input type="checkbox"/>	Low Risk <input type="checkbox"/>	Need More Info <input type="checkbox"/>	Not Applicable <input type="checkbox"/>
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Yes	No	Need More Info	Not Applicable	FACTORS
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Engineering standards have been developed to ensure that bridges, overpasses and other transportation infrastructure are well built and safe. Have new and past construction projects been built without being regularly inspected and/or have construction standards not been regularly enforced?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there major older bridges or highway overpasses which have not been recently reviewed by a structural engineer?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there major older bridges or highway overpasses which have not been well maintained?

Risk Assessment Resources

Historical Events – General Information

Please Note: See your Provincial/Territorial Risk and Resilience Information Guides for additional resources, including information regarding your provincial or territorial Emergency Management Organization (EMO). EMO websites generally provide information specific to the hazards in your territory or province.

Resource
<p>The “Canadian Disasters - An Historical Survey” website by Robert L. Jones provides a great list of past disasters which have occurred since the 1500s in Canada and have resulted in at least 20 deaths.</p> <p>http://web.ncf.ca/jonesb/DisasterPaper/disasterpaper.html</p>
<p>The Public Safety Canada “Canadian Disaster Database” contains a list of past disasters in Canada. Note that it has not been updated since 2005.</p> <p>http://www.publicsafety.gc.ca/prg/em/cdd/srch-eng.aspx</p>
<p>Wikipedia has a list of disasters in Canada and links to various events; however, it does not have a lot of information about British Columbia.</p> <p>http://en.wikipedia.org/wiki/List_of_disasters_in_Canada</p>

SOS! Canadian Disasters is supported by Library and Archives Canada, and provides some interesting stories on historical events and also has a great website on an education program (Grades 7 to 12) on understanding hazards and disasters in Canada.

<http://www.collectionscanada.gc.ca/sos/index-e.html>

CBC Archives have a wide variety of news clips on historical and current disasters in Canada as well as educational information on hazards for teachers.

<http://archives.cbc.ca/search?q=disasters&RTy=0&RC=1&RP=1&RD=1&RA=0&th=1&x=10&y=14>

Dam Failure and Structural Collapse References

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- ³ Pisaniello, J. D. (2010). Attitudes and policy responses to australian farm dam safety threats: Comparative lessons for water resources managers. *International Journal of Water Resources Development*, 26(3), 381-402.
- ⁴ Bowles, Jennifer. (April 15, 2008). Earthquakes: New Forecast, Same Fears; Living With Risk; California Study Rejiggers Inland Causes For Concern. *The Press Enterprise* (Riverside, CA.), SECTION A01.
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- ⁶ Response to Recommendations Contained in the Report: "Review of the Testalinden Dam Failure" (July 2010) British Columbia" Retrieved March 25 2011 from http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/cabinet/response_to_dsg_recommendations_14Oct2010_final.pdf
- ⁷ Fort Mc Murray Today. Retrieved April 14 2011 from <http://www.fortmurraytoday.com/ArticleDisplay.aspx?archive=true&e=1826377>
- ⁸ CBC. Retrieved April 14 2011 from <http://www.cbc.ca/news/canada/saskatchewan/story/2011/03/01/sk-lebret-hockey-arena-roof-110301.html>
- ⁹ Homeowner protection Office (2011). "Building Code." Retrieved February 27 2011 from <http://www.hpo.bc.ca/building-code>
- ¹⁰ Bodily, Lucy. (2008). Seattle Weighs Upgrades for Unreinforced-Masonry Buildings. *Engineering News Record*. Vol: 206; Issue 18, 13
- ¹¹ Seim, Charles. (2008). Why **Bridges** Have Failed Throughout History. *Civil Engineering*. Vol. 78. Issue 5. 64-87.