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## The Fault Line Threatening Dams

Deficient structures, earthquake risks raise possibility of potentially catastrophic flooding

*By Jim Carlton*

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FREMONT, Calif.-The coastal mountains that frame this working-class city next to San Francisco Bay harbor a hidden menace: a reservoir 10 miles away that sits next to an active earthquake fault, which experts say could cause a dam break and flood thousands of homes.

The potential threat is so severe, the owner of the Calaveras Reservoir decided to build a replacement dam. But seven years after that work began, the dam is unfinished and isn't expected to be complete until 2019 -- four years behind schedule.

The issues hampering the Calaveras Reservoir project show how difficult it can be to repair or replace an old dam, which is of growing concern nationally.

An estimated 27,380 dams, or 30% of the 90,580 listed in the latest 2016 National Inventory of Dams, are rated as posing a high or significant hazard. Of those, more than 2,170 are considered deficient and in need of upgrading, according to a report by the American Society of Civil Engineers. The inventory by the U.S. Army Corps of Engineers doesn't break out which ones are deficient.

But funding and inspection staffing are considered inadequate, the civil engineers' report said. An estimated \$64 billion is needed to upgrade those dams, including \$22 billion for those posing the highest hazard, according to the Association of State Dam Safety Officials, a nonprofit group in Lexington, Ky.

"It's a huge problem with limited resources," said Ivan Wong, a consulting seismologist from Walnut Creek, Calif., who works on dam projects nationally. "We can barely pay for our schoolteachers, but if a dam fails and there's a population downstream, we're talking about a disaster. We have to fix our dams, there's no doubt about it."

At the Calaveras dam, California's Division of Safety of Dams in 2001 ordered the San Francisco Public Utilities Commission to keep its 31 billion-gallon capacity Calaveras Reservoir no more than 40% full.

Utility officials say the extra time is needed to make the dam -- with a 1,200-foot-wide base and spillway walls up to 4 feet thick -- hopefully fail-proof.

"It's better to plan for the worst and hope for the best," Dan Wade, who oversees the \$800 million project, said on a tour on Wednesday. The cost is double the original \$400 million estimate.

Earthquakes pose especially big risks for dams. The seismic threat is highest along the West Coast, including Washington and Oregon, which scientists say could see rare but potentially catastrophic quakes.

Few states face as much of an earthquake threat as California, where nearly three- fourths of the state's 1,585 dams are rated as having high or significant risk of failure.

Like its predecessor and many others in California, the new Calaveras dam is being constructed largely out of rock, dirt and other natural materials. Engineering experts say earthen dams of sufficient size are designed to withstand most earthquakes. The Calaveras dam is being strengthened, in part, by having zones of compacted material, including a thicker core of impermeable clay.

One problem, experts say, is that many were built decades ago, when less was known about what a strong earthquake could do.

Engineers didn't realize then that the loose rock and soil they used to form the base of some dams could liquefy in a strong earthquake, potentially causing the top of the structure to deform and spill.

State officials have determined the 220-foot- high Calaveras Dam poses a flooding threat because the base of the 92-year- old structure was built atop loose earth on the site of a previous failed dam. About 300,000 people live in a flood zone along Alameda Creek below.

"It would be disastrous if this thing were to fail, because you have huge urban areas downstream," said Jeff Miller, executive director of the Alameda Creek Alliance, a nonprofit environmental group.



home is free of potential fire **hazards** and by having a fire escape plan, you and your family will have a better chance at staying safe.

4. The bombs also released **hazardous** chemicals into the air, which remained in the atmosphere for some time. The air made people very sick.
5. The new legislation requires e-waste to be dumped at **hazardous**, or dangerous, waste disposal sites rather than in landfills. Several other states are considering similar laws.
6. It didn't seem like a fire **hazard** at the time, but when 11-year-old Erin plugged her new computer into the extension cord, she heard a pop and saw a spark come from the outlet. She quickly unplugged her computer, and ran and got her mom.

# structure

struc · ture

## Definition

### noun

1. a thing that is made up of different parts that are connected in a particular way.

*A human cell is a complicated structure.*

*That new hotel is an interesting structure.*

2. the way in which the parts of something connect with each other.

*A carpenter knows about the structure of furniture.*

## Advanced Definition

### noun

1. a thing consisting of a number of elements joined together in a certain way.

*A human cell is a complicated structure.*

2. the way in which such a thing is joined together.

*We're studying the structure of atoms in chemistry class.*

3. anything, esp. a building, that has been constructed.

*They've finished building the new structure for the playground.*

4. the relationship between and among the parts of a relatively complex process or entity.

*On our first day at the job, we learned about the structure of the organization.*

5. a planned way of proceeding that imposes some degree of discipline and places limits on individual choice.

*Some children can work independently, but others require more structure so that they can concentrate on their task.*

### transitive verb

1. to give organization to; arrange.

*You structured your essay very logically.*

## Spanish cognate

*estructura*: The Spanish word *estructura* means structure.

### These are some examples of how the word or forms of the word are used:

1. Do you know how to change the properties, **structure** and state of matter of a substance? If you have made ice before, the answer is yes.
2. With those who are willing to join, let us cooperate to reduce the burden of arms, to strengthen the **structure** of peace, to lift up the poor and the hungry.
3. The Empire State Building was built at the site of the famous Waldorf-Astoria Hotel, a lavish **structure** that, by 1929, was no longer up to the demands of the modern world.
4. Other times, they try to make robots that can move in non-traditional ways. In one instance, they created a funny sort of robot that doesn't have very much **structure**, just a big blob of muscle.
5. This tendency to stay connected to other liquid bits of water is what makes water pool together on a table, if you spill a glass. What could force it to abandon its rigid **structure**, though, is heat.
6. Truss bridges, however, feature loadbearing **structures** called trusses, which are connected elements forming triangles. These are one of the oldest types of modern bridges, and are one of the cheapest to make, since they often require less material than other bridges.
7. The image displayed on the computer screen suggests that T. rex's bone**structure** would have made it impossible for the lumbering giant to reach that speed. "The computers answer questions we wouldn't have even thought of asking a few years ago," Mehling told Senior Edition.
8. The reef may look like a rock but it's actually alive. Coral reefs are underwater **structures** that are made by corals-tiny animals that are related to jellyfish. The coral have tender bodies that are vulnerable to attack, so they secrete a hard substance called calcium carbonate to protect their exteriors.
9. It is now considered good practice to minimize plowing of the land to preserve the integrity of the soil. Crop rotation is a good alternative: planting different kinds of crops can improve soil **structure** and keep the soil enriched with necessary nutrients and minerals, and with better soil, frequent plowing becomes less necessary.
10. Plain old water ice is composed of two atoms of hydrogen and one atom of oxygen-H<sub>2</sub>O. Not all water ice is created equal, however. "You can arrange the hydrogens and oxygens in different ways," Stewart says. Scientists know of at least 15 different crystal **structures** of frozen H<sub>2</sub>O, and more are being discovered all the time.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. A new replacement dam for the Calaveras Reservoir is being built. Where is the Calaveras Reservoir located?

- A. It is located in Fremont, California, next to an active volcano.
- B. It is located in Fremont, California, next to an iceberg.
- C. It is located in Fremont, California, next to an active earthquake fault.
- D. It is located in Fremont, California, next to a popular beach.

2. The text describes a major problem affecting a significant number of dams throughout the United States. What is this problem?

- A. Many dams are built with a thicker core of impermeable clay.
- B. Many dams need to be upgraded but funding and inspection staffing is limited.
- C. Many dams are strengthened by zones of compacted material.
- D. Many dams are built in areas with lots of storms, and are likely to overflow.

**3. Read the following sentences:**

One problem, experts say, is that many [dams] were built decades ago, when less was known about what a strong earthquake could do.

Engineers didn't realize then that the loose rock and soil they used to form the base of some dams could liquefy in a strong earthquake, potentially causing the top of the structure to deform and spill.

State officials have determined the 220-foot- high Calaveras Dam poses a flooding threat because the base of the 92-year- old structure was built atop loose earth on the site of a previous failed dam. About 300,000 people live in a flood zone along Alameda Creek below.

Based on this information, what might an earthquake cause to happen if it takes place near a dam that is poorly constructed?

- A. The earthquake may end up causing the base of the dam to become more compact and stronger.
- B. The earthquake may end up causing the dam to be able to hold more water.
- C. The earthquake may end up causing the dam and the water inside it to heat up.
- D. The earthquake may end up causing the dam to break and the water to flood nearby areas.



4. Based on the text, why might the California's Division of Safety of Dams have ordered in 2001 that the Calaveras Reservoir be kept at no more than 40% full?
- A. to limit the potential flooding damage that could be caused if an earthquake happens and the dam spills over
  - B. to increase the potential flooding damage that could be caused if an earthquake happens and the dam spills over
  - C. to limit the amount of water being used during a time when the state was experiencing a drought
  - D. to decrease the chances of an earthquake taking place and causing the dam to spill over
5. What is the main idea of this text?
- A. Many dams in California are at a greater risk of breaking and flooding areas because they are located near active earthquake faults. For this reason, the Calaveras dam in Fremont, CA is being replaced with a new one that is better built.
  - B. Thirty percent of the dams in the United States are rated as posing a high or significant hazard. Many of these dams have bases formed from loose rock and soil, which could liquefy in a strong earthquake.
  - C. Billions of dollars and inspection staffing is needed to repair and replace many damaged dams across the United States. Many states do not have the funding or the resources for these big construction projects.
  - D. When many of the country's dams were built, engineers didn't understand the extent of the damage earthquakes can cause them. Since then, we have more information about how earthquakes can impact dams.
6. Throughout the text, the author provides quotes from different people. Why might the author have included these quotes?
- A. to allow the reader to feel a personal connection with the people in the text they probably do not know
  - B. to present to readers information that contradicts the facts and ideas shared in the text
  - C. to help readers understand how quotes can be used correctly in news articles
  - D. to add the perspectives and insights of people who are involved with or understand the issues discussed in the text

7. Choose the answer that best completes the sentence below:

The new Calaveras Dam has been engineered to prevent it from breaking during an earthquake. \_\_\_\_\_, it is being strengthened, in part, by having zones of compacted material, including a thicker core of impermeable clay.

- A. On the other hand
- B. However
- C. For example
- D. In conclusion

8. Why did the owner of the Calaveras Reservoir decide to build a replacement dam?

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9. Why is it especially dangerous that close to 1,100 dams rated as having high or significant risk of failure are located in California? Use evidence from the text to support your answer.

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**10.** Imagine you've been placed in charge of a large project to repair or replace over 2,170 dams in the United States that are considered deficient.

Explain what you would consider in your decision about which dams to repair or replace first.

Use information from the text to support your answer.

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C. Billions of dollars and inspection staffing is needed to repair and replace many damaged dams across the United States. Many states do not have the funding or the resources for these big construction projects.

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8. Why did the owner of the Calaveras Reservoir decide to build a replacement dam?

The reservoir sits next to an active earthquake fault which could cause the dam to break and flood thousands of homes. Because this potential threat is so severe, the owner **of the Calaveras Reservoir decided to build a replacement dam.**

9. Why is it especially dangerous that close to 1,100 dams rated as having high or significant risk of failure are located in California? Use evidence from the text to support your answer.

California faces a very high threat of earthquakes. Earthquakes pose especially big risks for dams as they could cause them to break and flood nearby areas if they sit near active earthquake faults. Thus, a significant number of people would be at risk for losing their homes, and potentially their lives to flooding if an earthquake causes a dam to break nearby.

**10.** Imagine you've been placed in charge of a large project to repair or replace over 2,170 dams in the United States that are considered deficient.

Explain what you would consider in your decision about which dams to repair or replace first.

Use information from the text to support your answer.

Answers may vary but should be supported by the text. For example, students may indicate that they would prioritize fixing or replacing dams that are near active earthquake faults, as the earthquakes may cause the dams to break and flood nearby places. Students may also indicate that within this group of dams that sit near active earthquake faults, they would prioritize fixing or replacing dams that have larger populations of people living downstream. Students may also add that budgetary constraints could help inform further prioritization.