Understanding the 17th Street Levee Canal Containment Wall Breach through pictures and a brief discussion

The containment wall is formed by a series of preform concrete panels joined end-to-end, and this wall is bedded in the earthern levee. A combination of two forces brought down sections of the wall -- hydraulic and gravity. Immense water pressure bears on the walls in times of high water levels in the canal. The same water pressure forces water to infiltrate the earthern levee, weakening it structurally. When the earthern levee is sufficently weakened, it begins to give way, and the panels above the "slump" lose that support. Then, it is only a matter of enough water pressure and gravity to effectively "drop" the panels, or enough water pressure to "blow out" panels when the water pressure against them overcomes resistance. Note how one panel was swept into an adjacent neighborhood.

Understanding the levee breach: a brief discussion of how the 17th Street levee canal containment wall failed.

The levee itself is earthen. The canal containment wall rests on, and is partially embedded in the earthen levee. This wall is formed by a series of preform concrete panels joined end-to-end.

The strength of the wall depends on the underlying support of the levee, and the strength of the attachments between individual panels.

Those are the Achilles heels of the wall, if you will.

When high water pressure due to high water levels, i.e., flood or surge, occurs, the following can occur.

Under pressure, water infiltrates [1] the earthen levee. When the earthwork is loaded with water, hydraulic pressures weaken the forces [2] within holding that earthwork together. Enough water will cause the earthen levee to slump as loosened soils move apart. Equally, the weakened earthen levee is more likely to be pushed or "blown out" by water pressure both from hydraulic pressure within the soil and from the flood water pushing laterally against it.

Once weakened to the point of slump or failure, the earthen levee no longer supports the panel or panels above. At this point, the panels are under the stress not only of water pressure pushing against them but also the force of gravity pulling down.

The preform concrete panels can withstand considerable pressure over their surface, and can withstand far more force than the attachments between the panels.

Bereft of support from below when the levee slumps or fails, the panels are bound to fail if sufficient water pressure pushes against them, and when they fail, they will almost certainly fail at the attachments -- individual panels will not break, but will tear away from their sister panels because the joints are the weakest point.

This description is simplified and doesn't go into actual pressures, etc., but I offer it to you so you can understand what you are looking at when you view pictures of the breach and wonder why the break looks so "clean."

I hasten to add one final thing. Where the panels fail is a matter of site and situation, and the result of one of the many amazing properties of water, namely its ability to find the weakest point in any formation, be it mountain or molehill. Any number of contributing factors may play a role in where a breach occurs, such as local eddies, wave action, topography, channel depth, to name but a few.

<u>A very important comment</u>

There have been numerous unsubstantiated and anecdotal claims that the levee or levees were "blown up." Most of these reports include mention of hearing loud noise like explosions. It is therefore vital to understand that when a structure such as the 17th Street levee and containment wall fail, it can do so rapidly, "explosively" even. A blow –out of the levee canal containment wall could most certainly generate loud noises, rumblings and "booms." Also, rushing floodwaters raging through the breach can pick up and carry large objects and these in turn can become sources of loud, booming noises as they slam into other debris, structures, etc.

<u>An important addendum</u>

I have only discussed one failure mechanism or process above. Another equally possible process by which earthen levees can fail is scour, or erosion of the earthen levee. Simply stated, the energetic force of turbulent water can scour away materials, to the point of mechanical failure and breaching. In fact, the US Army Corps of Engineers has proposed that scour, or erosion was the most likely agent of the levees' demises. (Source: USACE press briefings transcripts 09/02 through 09/08 available at http://www.usace.army.mil)

Endnotes

1. "Under pressure, water infiltrates the earthen levee." Water permeates the unconsolidated soils, or "clasts." Water, under pressure permeates spaces between clasts Once saturated, cohesive forces, that is to say the forces that normally hold the clasts together, are diminished by lubrication, while simultaneously hydrostatic pressure pushes clasts apart. Once the forces pushing the clasts apart overcomes the cohesive forces holding them together, the soil, in essence, undergoes liquefaction and is prone to collapse under the effect of gravity plus any additional weight or force bearing down or against the soil, i.e., the force of external water pressure from the canal waters as well as the weight of the canal wall above. Ultimately, the soils will loosen and push out, or flow out, often in a sudden collapse, or "blow-out."

The same process occurs in emergent(surface) landforms, and results in landslides, mudflows etc. In the case of earthen levees, it is the hydraulic pressure from several added feet of water in floods that begins the process, while in emergent, or surface features such as hillsides, it is often the input of vast quantities of water from heavy precipitation events that sets the chain of events in motion.

2. Many forces act to hold the clasts together including hydrostatic, friction and cohesion as well as gravity, expressed in simplest terms.