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Lessons Learned

Looking for Clues

At the remote control center for a hydro plant providing power to a mine in the sub-arctic, a warning light came on to indicate high water level in the powerhouse sump. Shortly afterward, the alarm sounded and another light indicated the start up of the large auxiliary pump.

The powerhouse was equipped with an open sump; two sump pumps; a small (50-millimeter) suction pump on float control, adequate for all normal seepage flows; and a large (200-mm) suction pump also on float control that could function as the draft tube dewatering pump, with the start-up float set about 1 meter above that for the small pump. Motors for both vertical axis axial flow pumps were safely located above tailwater level.

Start up of the large pump indicated a large flow into the sump, which was a cause for concern. A technician was dispatched by snowmobile to the powerhouse to determine the cause of the large water flow. He telephoned the control center to advise that a stream of muddy water was emerging from the bottom of the powerhouse door and flowing into the sump. The pumps appeared to be handling the flow. Outside, the ground was covered with almost a meter of snow and no evidence of the water flow. However, the suspicion was that the water was coming from the toe of the earthfill dam, which abutted the powerhouse.

The mine manager was apprised of the situation, and he immediately called the geotechnical engineer who had designed the dam, which had only been in service for a few months.

The dam engineer arrived at the site the next day to find that the snow had been removed from the front of the powerhouse door, and that the muddy flow of water was coming from the toe of the dam. Because the dam stretched for about 300 meters to the abutment, no attempt had been made to continue clearing the snow.

Donning snowshoes, the engineer then walked the full length of the dam toe and back along the crest, pausing for a moment at a point some 30 meters from the powerhouse. He continued to the powerhouse wall, down the downstream slope (2.5 vertical to 1 horizontal) of the dam, and back 30 meters along the toe. From this vantage point, he advised the mine manager to have the snow cleared from the downstream face over an area 1 to 5 meters below the dam crest, and over a width of 7 meters. (Because the temperature was about -20 Celsius, the engineer thought it best to

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return to the mine cafeteria for lunch while the snow was being cleared!)

Upon returning, the engineer found that the downstream face of the dam revealed a 4-meter-long horizontal crack about 2 meters below crest level from which muddy water was seeping and flowing down the exposed face. The geotechnical engineer reasoned that the crack, which was located over the diversion trench used during construction, was due to differential settlement of the fill, and that the top 2 meters of frozen material at the crest had spanned the width of the trench, resulting in the crack. The headpond was lowered by 1 meter to temporarily stop the flow of water through the crack. Repairs were completed the next summer by re-compacting the crest area over the diversion trench.

On leaving the site, the mine manager asked the engineer how he knew where to excavate the snow, since the entire area was covered with an even blanket of snow. His only reply was a smile and one word — "experience." Over the years, the story was repeated among the geotechnical community, but the engineer steadfastly refrained from divulging the secret of his "X-ray eyes."

Many years later, after we had worked together on four other dams, I asked him how he had located the crack. His answer was the essence of simplicity. He had arrived at the site when the position of the sun was a few degrees above the plane of the dam's downstream slope. The flat slope was evenly illuminated except for one area in shadow, indicating a depression in the snow. He reasoned the depression could only be caused by seepage melting the underside of the overlying snow, resulting in local settlement of the snow.

The lesson learned: structures in distress usually exhibit some clues to the cause of the distress. Learning to find and interpret these clues can be valuable in solving problems before they intensify or cause costly damage.

— By James L. Gordon, B.Sc., hydropower consultant