

Closure to “Flap Gate Design for Automatic Upstream Canal Water Level Control” by Charles M. Burt, Russdon Angold, Mike Lehmkuhl, and Stuart Styles

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The discussion by Hager is appreciated. Our work was conducted before the Raemy and Hager (1998) paper was published, and we were not aware of its existence when our paper was written. Our work would have benefited from the Raemy and Hager paper (1998) if it had been available then. It is an excellent contribution to the subject, and covers several technical details better than we did, plus it includes some topics that we did not discuss.

The solution of the opening moment (couple) for the Raemy and Hager design is simpler than for our design. Raemy and Hager achieved this simplicity by placing their counterweight in a different plane than the flap, enabling them to always have the pivot at the same point—apparently very close to the upstream water surface. In contrast, with our design each gate has a different vertical and horizontal distance between the hinge and the counterweight. We maintain a substantial vertical distance between the hinge (pivot) point and the water surface.

From a construction standpoint in California conditions, our design has advantages. First, the bearings with our design are always well above the water level. This is important because the majority of the installations in California use this gate installed inside existing flashboard structures. It would be difficult to install bearings close to the water surface. Furthermore, in silty water one would expect the bearings to be damaged if they are wet.

Second, the construction of our design is simple because everything except the bearing assembly is built in the same plane. The vast majority of the construction is done in irrigation district welding shops, where flat-plate construction has definite advantages.

Although the opening couples for the Raemy and Hager gate are computed simply and accurately, their results are only for a suppressed sidewall condition. None of the 100+ installations that I am aware of in California have suppressed conditions. The free discharge we see on the sides and bottom complicates the couple computation because the pressure approaches zero on the sides of the flap as it opens, as well as on the bottom and top of the flap. Our pressure distribution testing results were from an unsuppressed condition. The pressure distribution will also change somewhat depending on whether the bottom of the flap (when closed) is on the floor or is elevated above the floor. In general, the installations with our design have the bottom of the flap well above the upstream floor.

The wide number of installation variations point out the need for field “tuning” of the final counterweight. Nevertheless, we have determined that the spreadsheet is sufficiently accurate if an allowance for one-time field tuning is made.

In the field, some of the gates have not required shock absorbers. However, most perform better with them installed—perhaps because of turbulent entrance conditions. Therefore, we always recommend them and they are only a minor expense.

We have not considered water tightness to be an important consideration. Just as Neyrpic gates are not water tight, our flap gate design does not normally provide an absolutely water tight fit. However, the leakage at low upstream water levels is small (we have not measured it), and if one puts a thin layer of flexible rubber on the flap, the overlap of the flap on the frame makes the gate almost completely water tight.

References

Raemy, F., and Hager, W. H. (1998). “Hydraulic level control by hinged flap gate.” Proc., Inst. Civil Engineers Water Maritime and Energy, 130, 95–103.