Discussion of “Optimal Design of Horizontally Framed Miter Gates” by Matteo Camporese

DOI: 10.1061/(ASCE)WW.1943-5460.0000205

Ali R. Vatankhah1 and Z. Aghashariatmadari2

1Assistant Professor, Irrigation and Reclamation Engineering Dept., Univ. College of Agriculture and Natural Resources, Univ. of Tehran, Karaj 31587-77871, Iran (corresponding author). E-mail: arvatan@ut.ac.ir
2Assistant Professor, Irrigation and Reclamation Engineering Dept., Univ. College of Agriculture and Natural Resources, Univ. of Tehran, Karaj 31587-77871, Iran. E-mail: zagha@ut.ac.ir

The discussers thank the author for nicely developing a general approach for the preliminary dimensioning of miter gate leaves based on the optimization of the angle between the leaves for the three most commonly used types of girder cross section (square, rectangular, and I-beam). The discussers, however, would like to add a few points.

The author gives only numerical solutions for the optimal angle $\alpha$ between the leaf and the normal to the lock wall for a number of relevant cases. This discussion presents an exact graphical solution and a nearly exact direct solution for the optimal values of the angle between the gate leaves and the normal to the lock wall. Moreover, in most applications, engineers may choose a smaller value of the optimal angle with lower cost of the structure without significantly increasing the structural stresses on the gates. Direct approximations for these cases are also presented by considering two different limits of 1 and 5%.

Proposed Exact Graphical Solution

The proposed model shown by Eq. (12) in the original article can be rewritten in a dimensionless form as

$$\kappa = \frac{1}{\sin \alpha} + \frac{\chi}{\cos^2 \alpha} \tag{1}$$

where $\kappa = 2\beta(1 - \lambda \tau)/\eta^2$ and $\chi = 1.5\eta(1 - \lambda \tau)/(1 - \lambda \tau^2)$.

The derivative of Eq. (1) with respect to $\alpha$ should be zero in optimal conditions; thus

$$\chi = \frac{\cos^4 \alpha}{2\sin^3 \alpha} \tag{2}$$

where $\alpha_* = \text{optimal value of } \alpha$.

Substituting $\chi$ from Eq. (2) into Eq. (1) yields

$$\kappa = \frac{1}{\sin \alpha_*} + \frac{\cos^2 \alpha_*}{2\sin^2 \alpha_*} \tag{3}$$

Eq. (3) indicates minimum dimensionless stress $\kappa$ in terms of $\alpha_*$. A graphical representation of Eqs. (2) and (3) is presented in Fig. 1. The figure is based on the practical range of $5^\circ < \alpha_* < 40^\circ$. For a given value of $\chi$, the dependent variable $\alpha_*$ is determined from the lower curve. Then, the minimum dimensionless stress $\kappa$ is determined from the upper curve for this value of $\alpha_*$. The dimensionless stress $\kappa$ is also determined by $\kappa = \frac{\chi}{2\beta(1 - \lambda \tau)}$.

For example, given $\chi = 12$, $\alpha_*$ is determined from Fig. 1 (lower curve) as $18.8^\circ$. Then for $\alpha_* = 18.8^\circ$, the minimum dimensionless stress $\kappa$ is determined from Fig. 1 (upper curve) as 16.5.

Proposed Direct Approximation

To provide the user with a single equation for determining the optimal value of $\alpha$, the inversion of Eq. (2) is estimated using a curve fitting regression technique (with $\alpha_*$ as the dependent variable, and $\chi$ as the independent variable) as follows:

$$\alpha_* = \frac{(23.4 + 3.34\chi^{0.184})^{1.375}}{1 + 1.52\chi^{0.4246}} \tag{4}$$

in which the unit of angle $\alpha_*$ is degrees. For the practical range of $5^\circ < \alpha_* < 40^\circ$, this direct solution has a maximum error less than 0.15% for $\alpha_*$ as shown in Fig. 2.

![Fig. 1. Design chart for the optimal value of $\alpha$ and minimum dimensionless stress $\kappa$.](image1.png)

![Fig. 2. Percentage error on approximation of the optimal value of $\alpha$.](image2.png)