HYDRAULIC SENSITIVITY OF BAFFLEED MODULES DISTRIBUTERS

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The sensitivity analysis approach is a simple "What-If" analysis, in which the behavior of the system is evaluated according to variations in input parameters. The hydraulic sensitivity indicator of an irrigation structure is defined as the ratio of relative (or absolute) variations of output hydraulic parameters to input ones. Sensitivity and sensitiveness for irrigation outlets (offtakes) were thoroughly analyzed by Mahbub and Gulati (1951)[1] and later used in India. Subsequent revisions may be found in Horst (1983), Shanan et al.(1986), and Albinson(1986). Renault and Hemakumara (1999) proposed a more comprehensive framework to analyze offtake sensitivity which included the conveyance effect (i.e. the impact of the offtake flow variation on the on-going discharge).

Baffle distributors are a type of free surface offtake equipment designed to supply a more controllable constant flows (Alsthom Fluid 1971).These distributors are manufactured in five series that are labeled X_i, XX_i, L_i, C_i, and CC_i, where i stands for the number of baffles, that is one or two (Delft Hydraulic 1989, Goussard 1993).To study the sensitivity of baffle distributors and to provide an appropriate indicator for this special type of offtakes, it is necessary to determine the depth-discharge relationships for all distributor types. In this research, these relationships were determined based on discharge-height characteristic curves provided by the manufacturer. Based on the curves, the permissible level variations range may be divided into three and five segments for the single and double-baffle distributors, respectively. For all the height zones of all distributors, the best fit equations were derived and studied thoroughly. The sensitivity of each baffle distributor gate was considered as a combination of the sensitivities of all height zones. To propose the most appropriate relation for determining the hydraulic sensitivity of a baffle distributor gate, a number of relationships were considered and went through a thorough test procedure, some of which are presented in Table 1. In the Table $\overline{S}_O$ = overall hydraulic sensitivity of a distributor gate; $\Delta H_{US(j)}$ = difference between the maximum and minimum flow depth of the corresponding jth zone (i.e. level range of the jth zone); S_j = sensitivity of jth zone; A_j = shaded area under the characteristic curve within

[1] Refer to the full paper for details

the jth zone; minimum discharge in the first height zones; and $\Delta q'$ and $\Delta H'_{US}$ = distributor discharge variation and upstream level variations corresponding to the minimums of the first and the maximums of the third (or fifth) height zones, respectively.

The result accuracy of each equation was evaluated to determine the most reliable equation of the Table. That is the discharge variation ranges were determined by multiplying the overall sensitivity value, $\bar{S}_O$, of each equation by the permissible variation levels. The results were, then, compared with the discharge permissible range, i.e. 20%. Accordingly, Eqs. A to F of Table 1 were judged based on the root mean square, RMS, produced based on the results of each equation. As shown in the Table, Eq. D seems the most appropriate and reliable one to determine the sensitivity of a given gate of a specific distributor. It means that the overall hydraulic sensitivity of baffle distributors is a function of the depth variation range in different height zones of the characteristic curve and the sensitivity associated with each specific zones. The distributor sensitivity is a function of the structure and the flow characteristics. Hence, any factor that may affect the two features will ultimately affect the distributor sensitivity and performance.

Table 1. Relations tested for determining overall sensitivity of baffle modules

Relation name	Single-Baffle Module	Double-Baffle Module	RMS
A	$\bar{S}_O = S_3$	$\bar{S}_O = S_5$	61.6
B	$\bar{S}_O = \frac{S_1 + S_3}{2}$	$\bar{S}_O = \frac{S_1 + S_5}{2}$	68.8
C	$\bar{S}_O = \frac{\sum_{j=1}^{3} S_j}{3}$	$\bar{S}_O = \frac{\sum_{j=1}^{5} S_j}{5}$	18.15
D	$\bar{S}_O = \frac{\sum_{j=1}^{3} \Delta H_{US(j)} . S_j}{\sum_{j=1}^{3} \Delta H_{US(j)}}$	$\bar{S}_O = \frac{\sum_{j=1}^{5} \Delta H_{US(j)} . S_j}{\sum_{j=1}^{5} \Delta H_{US(j)}}$	4.33
E	$\bar{S}_o = \frac{\Delta q' / q_1}{\Delta H'_{US}}$	$\bar{S}_o = \frac{\Delta q' / q_1}{\Delta H'_{US}}$	8.1
F	$\bar{S}_O = \frac{\sum_{j=1}^{3} S_j . A_j}{\sum_{j=1}^{3} A_j}$	$\bar{S}_O = \frac{\sum_{j=1}^{5} S_j . A_j}{\sum_{j=1}^{5} A_j}$	11.1

Using the depth permissible range of each distributor, and Eq. D, values for the hydraulic sensitivity of different types single- and double- baffle distributors were calculated and plotted in Fig. 1. The results reveal that X_1 type distributor with a hydraulic sensitivity of 0.285 is the most sensitive baffle distributor to variations in flow level. A sensitivity of 0.285 represents a variation of 28.5% in discharge delivery for a variation of 10cm in flow level. The hydraulic sensitivity of single baffle of each type is 2.5 times that of double-baffle distributors.

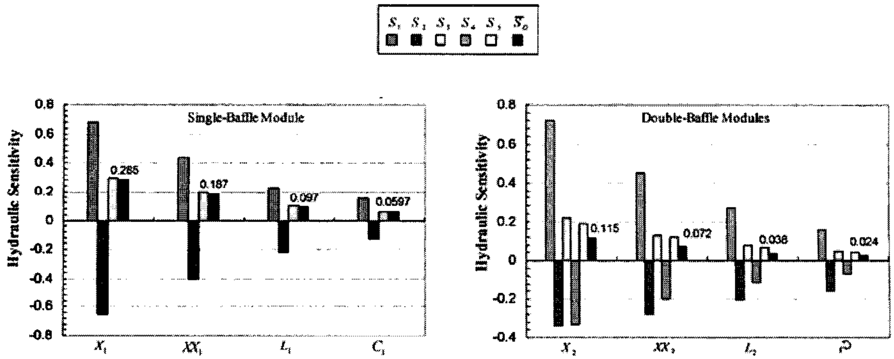

Fig. 1The hydraulic sensitivity values of baffle modules