REPORT ON THE FIELD TEST PERFORMED ON FORDWAH BRANCH, CHISHTIAN SUBDIVISION

Report on the Field Test performed on Fordwah Branch, Chishtian Subdivision

by

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Bahawalnagar, 23-26 August 1995

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1. Introduction

1.1. IIMI/ID COLLABORATION

IIMI has been involved in research activities in the Fordwah Eastern Sadiqia for four years, and some results are now being tested in the field, to demonstrate the possibility of a productive collaboration work between researchers and managers.

The XEN Fordwah, through his guidance and encouraging attitude helped us to perform this second field test. He kindly supervised this experiment.

The SDO Chishtian and SDO Headquarters also fully cooperated, and provided useful advise. The field test could not have been successful without their cooperation, and the results obtained are mostly due to their implication.

The field staff (mainly gauge readers) were the principal actors of this field test as they are the ones who operate the gates.

1.2. FORDWAH BRANCH

1.2.1. General description

Fordwah Branch was designed and constructed at the end of the 1920s as part of the Sutlej Valley Project. Fordwah Canal offtakes from the left bank of the Sutlej River, from Suleimanki barrage, then separates at RD 44.8 into two branches, namely Fordwah and MacLeod Ganj Branches.

Fordwah Branch has a total length of 123 km, 38.4 of which are in the Chishtian Subdivision (from RD 245 to RD 371, tail of the main branch). The design discharge at RD 199, handover point of the Chishtian Subdivision is 1282 cusecs. Its width is about 115 ft at RD 199, and 50 ft at the tail. The average slope is 0.020%, or 1/5000. Water is distributed to secondary channels (distributaries) through 14 offtakes, flat sliding gates, culverts or open-flumes. There are also 19 direct outlets (pipes and APM). The total CCA (Culturable Command Area) of Chishtian Subdivision is 67,597 ha. Out of the 14 disties, 9 are non perennial, which means that they are entitled to water during the Kharif season only, and 5 are perennial, with supplies the year round.

The water levels are maintained along the canal by means of 5 gated cross regulators, and two weirs. Most of the distributaries offtake just upstream of a cross regulator, only three of them, Phogan, Jagir and Soda are not under the direct control of a regulator.

The seepage in this canal, computed with an inflow-outflow method is about 9.3 cusecs per million square feet (see Training report on field calibration of hydraulic structures, 1995).

1.2.2. Operational problems

The discharge at RD 199 is most of the time lower than the design discharge [1], leading to siltation in the upstream reaches. The banks are also in poor condition, especially at points where cattle cross regularly. This has resulted in a loss of the capacity of reaches, giving a smaller security margin for operations. However, the fourth reach between RD 316 and RD 353 is in good shape, and has a potential storage capacity that is not always used in present situation. The fifth reach (between RD 353 and RD 371), located at the tail of the Subdivision, is the one with the smallest margin of operation, as the left bank is in a bad shape, and an abrupt drop in the elevation of the left bank at RD 363 implies a risk of overtopping. The gauge reader at RD 371, tail of the main branch, is very limited in his operations because of this.

A lot of responsibility is left to the gauge readers, especially in case of emergencies. In routine management, they perform a good local control. But this local control cannot tackle the fluctuations that enter the system, as they are amplified by operations inside the Subdivision. The result is a highly variable discharge at the tail, where a lot of breaches occur in Azim disty, partly because of these reasons.

As a result, the canal is almost never in steady state, and gates are operated every day (up to 18 times a day at RD 371).

A MSc study was carried out in Fordwah Branch, Chishtian Subdivision, using a hydraulic model to determine the physical constraints of the system and the technical scope for improvement in operations. At the same time, the SDO Chishtian was also addressing the operational problems inside the system. Both experiences were put together to implement some scenarios simulated in the model, and test them in the field.

[1] In a joint effort, I&PD and IIMI did discharge measurements in Chishtian Subdivision during a calibration training. The discharges used in this report are calculated according to the discharge tables established during this calibration training (see Training report on field calibration of hydraulic structures, 1995).

2. Objectives and implementation of the field test

2.1. OBJECTIVES

2.1.1. The first objective of this test was to reach a **stable flow** in the Subdivision. This was done while the Subdivision was in first preference in the rotational program, so that fluctuations coming upstream of RD 199 could be passed in Sikandar or in Rojahanwala disties. The operations inside the Subdivision had to be kept to a minimum so that no fluctuation would be created by operations inside the Subdivision.

2.1.2. Once this stable flow was reached, after 2 or 3 days, the objective was to **pass a wave** from RD 199 to the tail (Azim disty). The gauge readers were to be informed about the approximate time of arrival and the amplitude of the wave (number of cusecs). The propagation of the wave, its amplification or attenuation was to be observed.

2.2. IMPLEMENTATION

This field test took place from the 23rd to the 26th of August 1995.

2.2.1. Steady flow: to reach a steady flow in the canal, we needed to have:

- a stable inflow
- a minimum of operations at cross regulators and offtakes

The SDO Chishtian kept his indent constant for the three days of the experiment at 1350 cusecs (from the 23rd to the 26th).

As the indent was kept constant, the inflow at RD 199 was rather constant between 1350 and 1400 cusecs (according to I&PD discharge table). The SDO Chishtian sent the Sub-engineer Tahkt Mahal to order the gauge reader at RD 245 to keep the discharge downstream his point at full supply (1025 cusecs), by closing some disties if necessary. He ordered the gauge reader not to operate the gates of the regulator, but to operate the gates of Daulat or Mohar disties instead (see Figure 1). This way, the discharge downstream this point was to stay constant as long as the inflow at RD 199 did not fluctuate too much.

To keep the operations at a minimum, the gauge readers at each control point were told not to operate the gates if the upstream level at their point was within a range of 0.2 ft around the pond level. By following this rule, the unjustified operations were eliminated, and no fluctuations are provoked inside the Subdivision.

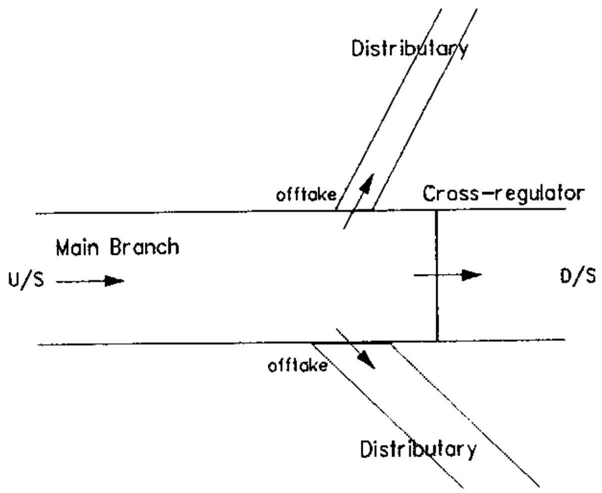


Figure 1: Main branch and distributaries at a cross-regulator

2.2.2. Positive wave propagation: starting from the steady state obtained in a first step, the objective was to create a wave of about 50 to 70 cusecs at RD 199, to follow its propagation while informing the gauge readers, to see the effect of this wave on the hydraulic state of the canal. Because of a drop in the discharge upstream of RD 199, it was not possible to create a significant wave, and only 17 cusecs were released downstream. Little waves were also created at other control points, as the first one was not big enough to create a significant fluctuation.

2.3. SUMMARY

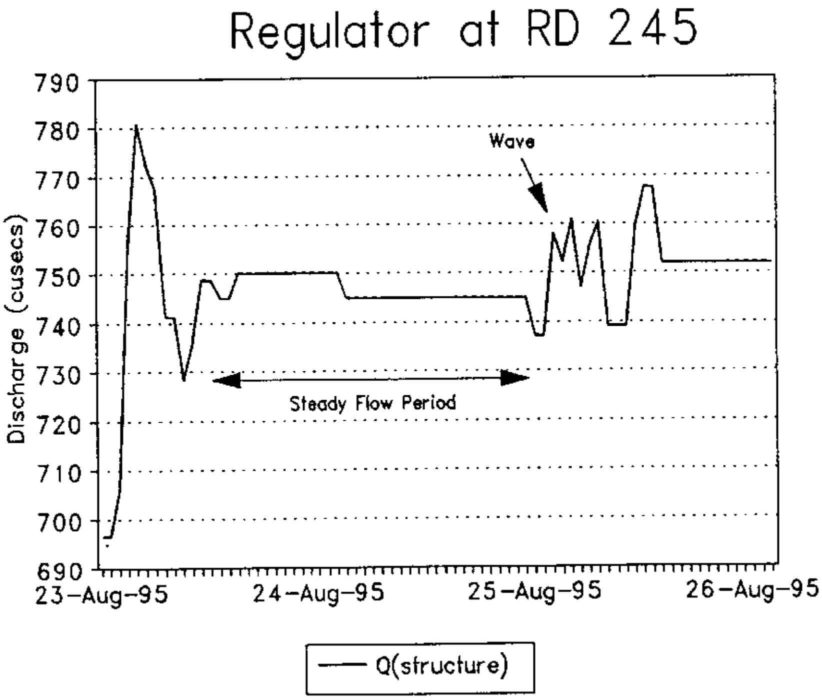
The exercise presented two phases: steady flow, and wave propagation. The first phase lasted 2 days, and the second one 1 day. The measures of water levels along the canal during the exercise were done by IIMI, to be able to evaluate the results of the test.

3. Results

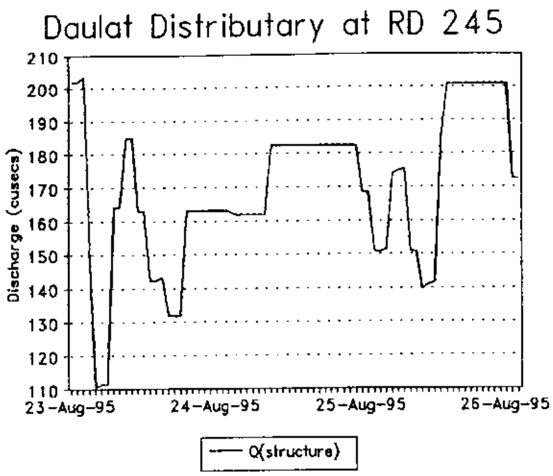
With an almost constant flow at RD 199, and a constant discharge downstream of RD 245, the fluctuations in the discharge passing downstream were reduced. There was almost no operations at cross regulators, allowing to stabilize the levels in the canal in less than 20 hours.

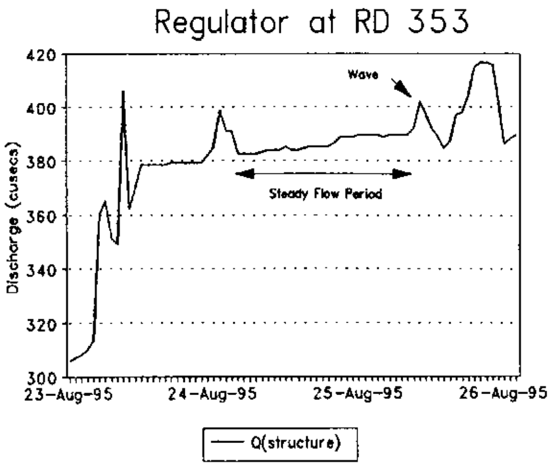
Steady flow:

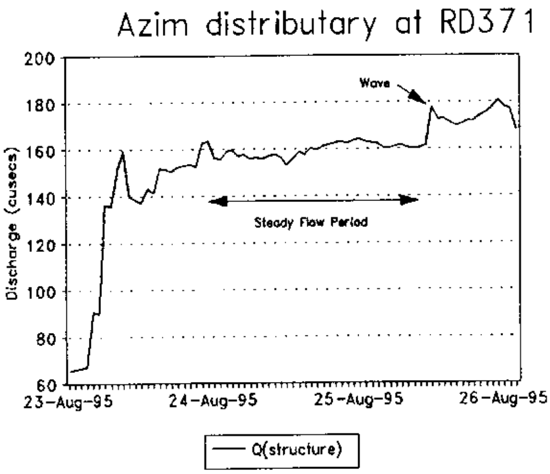
The canal stayed in steady flow for more than 36 hours. The discharge downstream the cross regulator at RD 245 was kept constant by operating Daulat disty, which could take the fluctuations coming from RD 199 (see appendix for the layout of Chishtian Subdivision).

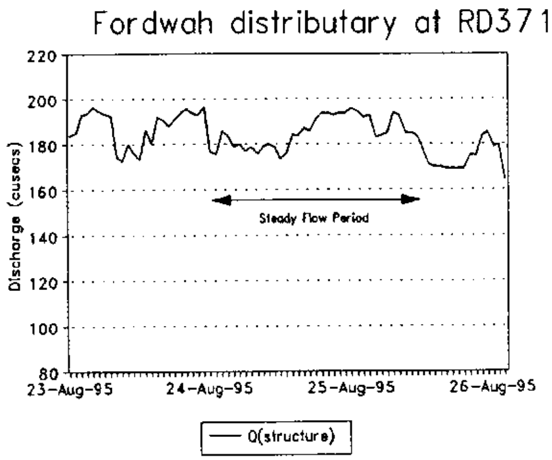


The discharge at RD 353 stays within a range of 20 cusecs during about 40 hours, allowing the gauge reader at RD 371 not to operate during more than 36 hours. The discharge in the distributaries at the tail of the system is fluctuating around an average value, but the gauge reader did not need to operate the gates. The fluctuations stay in a range of about 20 cusecs.









Wave propagation:

RD 199: a wave of 17 cusecs was provoked at RD 199 at 4:15 AM the 25th of August. Its effect was felt at 7:30 at RD 245

RD 245: as the wave received was too small, another wave of 30 cusecs was created by opening the regulator.

RD 281: this fluctuation arrived at RD 281 at around 10:05. The gate keeper at this point kept a high pond level, which tempered the wave, and only 10 cusecs arrived at RD 316.

RD 316: another wave was created at that point, of 10 to 12 cusecs at 12:45.

RD 353: a small increase in water level was felt at RD 353 at 14:45, but as the wave was not sufficient, the gate at this point was opened to release water at 14:50.

RD 371: this wave took 1.5 hour to reach the tail, where the gauge reader operated Azim and Fordwah at 17:20. He opened Azim and closed Fordwah disty.

The number of operations at cross regulator decreased dramatically during this steady flow period. The gauge reader at RD 371 did not move his gates during more then 36 hours, a situation which never occurred before in 7 years. The upstream level at his point were nonetheless fluctuating a little bit, but he had information on the future state of the canal: as no big fluctuation was supposed to take place, he could allow bigger fluctuations than usual, without moving the gates, which could have amplified them.

The table below compares the number of operations at regulators during the field test and another period of 60 hours monitored between the 3rd and 5th of June 1995. During this period also, the inflow at the head was not too much fluctuating, at least for the first 30 hours. The decrease in number of operations is clearly visible at the tail, RD 371, where fluctuations usually provoke many operations at this point.

Table 1: Number of operations at cross regulators during two 60 hour periods.

Regulators	**Monitoring period June 1995**	**Field test August 1995**
RD 199	7	9
RD 245	11	7
RD 281	11	5
RD 316	5	4
RD 353	11	7
Azim	20	7

4. Discussion of results

4.1. STEADY FLOW

With a rather stable inflow and a few number of operations inside the system, the canal reached a steady state in less than 20 hours. Having information on the future state of the canal, the gauge readers were able to minimize the number of operations, tempering the little fluctuations they received instead of amplifying them. As a result, the water distribution to secondary canals was constant at full supply. As gauge readers had information on future perturbations, the safety margin could be kept at each point, with the canal running at full supply.

4.2. WAVE PROPAGATION

Starting from this very good steady flow, we tried to perturbate the system by creating some waves, and studying the reactions of gauge readers to these waves. Each time, the gauge reader downstream of the point where the wave was coming from was informed about the time of arrival and the amplitude of the wave. They showed a very good hydraulic knowledge stemming from experience, and were able to temper these waves without any problem. It also came out of the experiment that it is quite difficult to pass water to the tail in times when the demand of water is high. Any increase in the supply upstream is taken by the disties in the middle, and only a small portion stays for the tail.

4.3. DISCUSSION WITH OPERATIONAL STAFF

The results of this experiment were restituted to the gauge readers, who identified the different conditions that made this test successful, and ranked them in order of priority.
The conditions identified were as follows:

1. Specific orders were given by the managers (XEN, SDO, Sub-engineer) to gauge readers.

2. The inflow at RD 199 was rather stable.

3. Communication was provided inside the system (IIMI vehicle), and information was given to the gauge readers (number of cusecs and time of arrival of the wave).

    - No rain occurred during this test.
    - High water demand for the crops.
    - Trained gauge readers.
    - No intervention from farmers took place during the test.

The gauge readers emphasized the fact that they requested some guidance from their managers, especially in times where changes occur in the hydraulic state of the canal (rain, change of rotation,...). They felt rather insecure when changes occur and they are not aware of them. The security margin they take in those cases sometimes lead to an increased risk of breaches.

The results were also jointly discussed with the manager. He stressed the fact that this study was limited to the main canal level, and did not take into account problems encountered at the distributary level; Shahar Farid disty, for example, is correctly fed in winter with 150 cusecs, while in summer, with 180 cusecs, the tail is still not getting water. The maintenance of distributaries is also a subject of study, but at a different level. At the main canal level, this field test showed some possible improvement that can be implemented.

5. Conclusions and recommendations

Conclusions:

1. This successful field test was made possible due to some conditions that have been determined and ranked.

The three most important conditions are:

- implication of managers
- information in the system
- stable flow at the head

The implications of the managers was a very important point, as well as the information inside the system. As the supply to distributaries was constant at full supply and the demand of crops was high, the farmers were satisfied, and very few interferences occurred during these three days.

2. The system is relatively robust. It is not perturbed by little fluctuations provided gauge readers are informed about future perturbations (timing, cusecs, origin).

3. For a period where the Subdivision is first preference, it is therefore possible to ensure a constant and full supply to distributaries, keeping a safety margin by giving information to gauge readers.

Recommendations:

1. This experiment could be extended to a longer period. It could be done again for a 10 day period, when the Chishtian Subdivision is in first preference.

2. Information should be conveyed to the gauge readers from the manager during this period. They requested for some guidance, especially when changes occur (rain, change in rotation, increase in indent). They want specific information concerning the time, the amplitude (number of cusecs), the reason for this fluctuation and its provenance.

Appendices

Layout of Fordwah Branch

Characteristics of distributaries in Chishtian Subdivision

Characteristics of distributaries in Chishtian Subdivision

Name of distributary	RD	CCA (ha)	Status[2]	Design discharge (cusecs)[3]
Daulat	245+600	13,255	NP	209
Mohar	245+600	1,706	NP	36
3L	245+600	1,166	NP	18
Phogan	267+700	949	NP	18
Khem Gahr	281+000	2,032	NP	30
4L	281+000	840	NP	16
Jagir	297+500	1,604	P	28
Shahar Farid	316+400	10,364	NP	153
Masood	316+400	3,004	P	35
Soda	334+000	3,935	NP	77
5L	348+800	357	P	4
Fordwah	371+600	14,847	P	158
Mehmud	371+600	813	P	9
Azim	371+600	12,191	NP	244

2 P=Perennial, NP=Non-Perennial

3 The design discharges of 3L and Jagir have been changed (former values: 23 for 3L and 39 for Jagir).

Layout of Fordwah Branch
Chishtian Subdivision