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# MAYNORD

## COMMENTS ON REBUTTAL TO ESTES PARK PAPER

Comments on Rebuttal to Vicksburg Front Estes Park Paper:

I will address the following items:

1) Do differences in GPS, confetti, and PIV prevent conclusions on MM flow patterns?
2) Is the ADCP data relevant?
3) Are the float velocities too low?
4) After having prepared the ASCE paper, read the rebuttal, and prepared this response, what are the appropriate conclusions?

Item 1: Do differences in GPS, confetti, and PIV prevent conclusions on MM flow patterns?

"A float will indicate the actual locus of a point moving with the fluid, which is called a path line" (Rouse, Engineering Hydraulics, 1950). Also from Rouse "a streamline is defined as a line which lies in the direction of flow at every point at a given instant." (I have to frequently remind myself of the difference between these two lines). Confetti and GPS floats are both path lines simply having different lengths. PIV is somewhat different because it interpolates the entire flow field to define streamlines. PIV in the Vicksburg MM was based on 200 frames at 30 frames per second and represents the best depiction of the flow field in the MM because it uses about 7 sec of model data whereas the confetti is based on probably a 0.5-1.0 sec camera shutter opening. If flow in the model or river was completely steady (no variation with time) at all points in the reach, confetti, GPS floats, and PIV would give identical flow patterns. We all know that flow in the river is not steady as shown by the model photos provided by MVS and the GPS floats at Vicksburg where path lines can cross. The three different methods show this unsteadiness in different degrees. Short confetti path lines would not show much of the unsteadiness that is present unless one compared several different photos. PIV would show very little of the unsteadiness that is present because of the averaging over 7 sec. Some small differences in PIV would be seen if comparing different 7 sec windows. The GPS floats released at different times and allowed to traverse the reach show much of the unsteadiness that is present in the river or model. If one understands these differences in the three methods, I believe the methods can be used to compare flow patterns in model and prototype. The most appropriate information from the micro model is the PIV data because it quantifies the velocity and uses a 7 sec averaging window compared to 0.5 – 1.0 sec with confetti. In addition, the confetti pictures in the Vicksburg Front model were difficult to use because only a few path lines could be defined.

Item 2: Is the ADCP data relevant?

When I first started this comparison, I planned to use float, confetti, GPS, and ADCP to make comparison. My abstract to Estes Park stated I would use ADCP. In preparing the paper, I looked at the stage for the ADCP data and stage for the float and PIV data and found they were significantly different. On 10 October 1999 when ADCP measurements were taken, the Vicksburg District website showed a gage reading at Vicksburg of 4.2 ft which is equal to 4.1 ft LWRP. This low water agrees well with comments by MVS that

they could not get across the middle bar when doing the ADCP transects. Based on conversations recently with Charlie Little of the Vicksburg District, the discharge at Vicksburg for a gage reading of 4.2 ft is 235000 cfs and average channel velocity is 2.8 ft/sec. The float data and the micro model PIV data were taken at about 19.5 ft LWRP which corresponds to a discharge of 537000 cfs. I considered these differences in stage and Q to be too large to use in the comparison. In addition, I could not compare the ADCP collected at low flow to the low flow PIV because Andy Gaines discounted the quality of the low flow PIV.

Another concern of using the ADCP was again heard at the Estes Park conference. MVS is certainly correct in stating that ADCP is widely accepted for measurement of total discharge. I heard no one advocating using ADCP velocities collected during a normal transect mode and comparing to model (physical or numerical) velocities. One or two speakers advocated against such comparisons. It has always struck me as impossible to obtain the average velocity at a point in an unsteady open channel flow when the ADCP meter is only measuring velocity at a point for a matter of seconds or less. Some people take the ADCP and sit at a point for enough time to collect reliable point velocities. One presentation at Estes Park concluded the ADCP had problems near the surface and another presentation concluded there were problems because of interference from the boat.

MVS expressed concern that their ADCP velocities at low flow were greater than the float velocities at medium to high flow. Elimination of the ADCP data based on low stage and Q makes it unnecessary to go into all the factors that could explain this but Charlie Little said the Vicksburg gage rating exhibits some loopiness. The ADCP data were taken on a rising stage and the float data were taken on a falling stage.

Item 3: Are the float velocities too low?

In my original analysis for the paper, I checked this issue by determining the average channel velocity based on discharge/area and comparing to surface velocity. I repeated that effort and will document herein. After some confusion on my part between gage reading and LWRP, the stages on the Vicksburg gage and discharge during the GPS float study were as follows:

| Date | Gage reading, ft* | Q, cfs** |
|---|---|---|
| 11 May 2000 | 20.6 | 565000 |
| 12 May 2000 | 20 | 550000 |
| 13 May 2000 | 19 | 525000 |
| 15 May 2000 | 18 | 510000 |

*From Vicksburg district web site

**From rating curve provided by Charlie Little at Vicksburg District, 6 August 2002.

Whether one averages all 4 days or the 12$^{th}$ and 13$^{th}$ when most measurements were made, the flow was about 537000 cfs during the float survey. The average gage reading

was 19.4. At Vicksburg gage which is 0.3 miles downstream of bridge, this corresponds to an LWRP = 19.3 ft.

The year 2000 cross section at RM 439.5 has an area of 126000 sq ft at 19.3 ft LWRP excluding area right of island which has limited flow because of the dikes. Based on Q/A, average channel velocity = 537000/126000 = 4.26 ft/sec = 1.3 m/sec. At RM 434.5, area is almost identical at 19.3 ft LWRP at 125900 sq ft.

Based on conversation with Charlie Little, average channel velocity at the Vicksburg gage at a stage of about 19.4 is about 4.5 ft/sec with a range from 4-5 ft/sec.

At the Estes Park, we heard an interesting paper by USGS on using surface velocity to conduct discharge rating. Our team talked about this same technique using PIV in micro model to determine flow splits in divided reaches. The ratio of depth averaged velocity/surface velocity is a major variable and typically varies from 0.7 to 1.0 with an average value of 0.85 being typical. Using depth average velocity of 0.85* GPS surface float velocity with incremental areas gives Q = 494000 cfs at RM 439.5 which compares reasonably well with gage value of 537000 cfs.

I must admit that I thought these GPS velocities were low when I first saw them. After comparing to Q/area, talking to Charlie Little about historical data, and using new USGS technique, the GPS velocities are correct.

Item 4: After having prepared the ASCE paper, read the rebuttal, and prepared this response, what are the appropriate conclusions?

On completion of the ASCE paper I looked equally at (1) path lines through the bend from micro model and prototype and (2) cross section plots of velocity to make my conclusion that model and prototype flow distributions are different. After looking at the unsteadiness of the path lines through the bend exhibited by the GPS floats that can not be seen (but is certainly present) in the model PIV and confetti, I can see how MVS takes the position that the differences make the conclusion doubtful. While I don't agree with their conclusion, I can see their position.

What I now focus on, and I tried to do at the Estes Park presentation, is the comparison of cross-section plots from PIV and GPS at the two upstream cross sections. These velocities are comparable. The PIV is averaged over 7 sec and the GPS was taken every three sec and velocity magnitude shown in ASCE plots are based on averaging over 60 sec. This velocity comparison shows a significant concentration of velocity on the left bank in the micro model that is not present in the prototype. More GPS floats would not change this finding. The occurrence of incorrect filling of the right bank side channel in the micro model only serves to reinforce this conclusion regarding the flow distribution.

Conclusions:

1) If one understands the differences between confetti, PIV, and GPS floats, comparisons can be made.
2) ADCP data are not relevant to this comparison.
3) Float velocity magnitude compares well with average channel velocity magnitude.
4) Focus of this comparison should be cross section velocity at two upstream cross sections using PIV in model and GPS in prototype.
5) Analysis of model similarity must also consider incorrect filling of side channel in micro model.
6) I stand by my conclusion in the Estes Park paper that the flow distribution in the Vicksburg Front micro model is not similar to the prototype.
7) I also stand by my statement at Estes Park that ice photos and ADCP comparisons have not been adequate to show agreement of flow patterns in micro model and prototype.
8) As I stated at Estes Park and will state in the final micro model report, the micro model should not be used for the fourth category of Navigability and flow patterns.

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