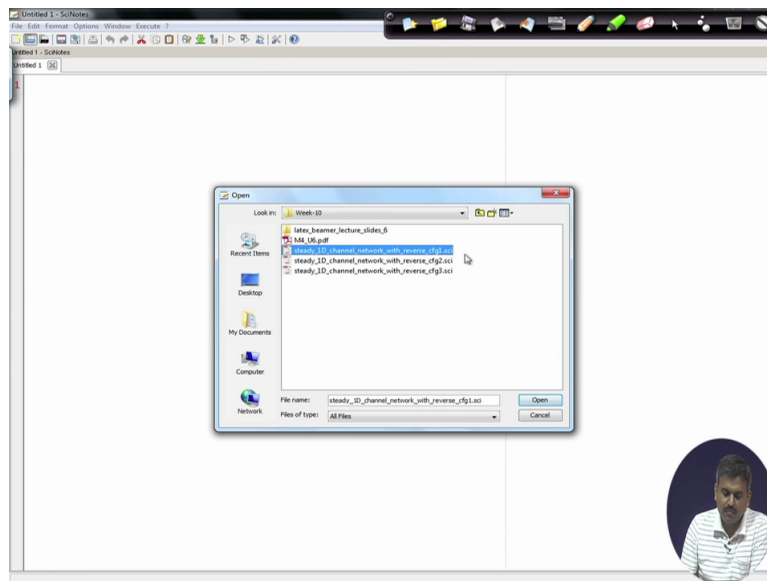


Computational Hydraulics
Professor Anirban Dhar
Department of Civil Engineering
Indian Institute of Technology Kharagpur
Lecture 43
Steady Channel Flow: Channel Network with Reverse Flow (Contd.)

If I consider this condition now in this case if I open my scilab so I can open this cfg steady 1D channel network with reverse cfg 1 that is configuration 1 which is the base configuration.

(Refer Slide Time: 00:52)



Now in this case the first line starts with `clc`, next line is `clear` that means clearing the console, clearing all the variables here. Next one is area calculation. This is dA by dy calculation. This is general one for trapezoidal section.

(Refer Slide Time: 01:19)

```

1 |clear
2 |clear
3 |function Av=areav(y,B,m1,m2)
4 |    Av=B*y+(1/2)*(m1+m2)*y^2;
5 |endfunction
6 |function dAv=dareav(y,B,m1,m2)
7 |    dAv=B+(m1+m2)*y;
8 |endfunction
9 |function Rv=HRV(y,B,m1,m2)
10 |    Rv=(B*y^(1/2)*(m1+m2)*y^2)/(B+(sqrt(1+m1^2)+sqrt(1+m2^2))*y);
11 |endfunction
12 |function dRv=dHRV(y,B,m1,m2)
13 |    Tw=B*(m1+m2)*y;
14 |    Pm=B*(sqrt(1+m1^2)+sqrt(1+m2^2))*y;
15 |    Rh=HRV(y,B,m1,m2);
16 |    dPdy=(sqrt(1+m1^2)+sqrt(1+m2^2));
17 |    dRv=(Tw/Pm)-(Rh/Pm)*dPdy;
18 |endfunction
19 |
20 |function M1iv=M1i(y1,Q1,y2,Q2,zv1,zv2,D1,D2,B,m1,m2)
21 |    M1iv=(y2-y1)+(zv2-zv1)+D1*(Q2^2*areav(y2,B,m1,m2)^(-2)-Q1^2*areav(y1,B,m1,m2)^(-2))+D2*(Q2*abs(Q2)*HRV(y2,
22 |    B,m1,m2)^(-4/3)*areav(y2,B,m1,m2)^(-2)+Q1*abs(Q1)*HRV(y1,B,m1,m2)^(-4/3)*areav(y1,B,m1,m2)^(-2));
23 |endfunction
24 |function dMdyiv=dMdyi(y,Q,D1,D2,B,m1,m2)
25 |    term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
26 |    term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
27 |    term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
28 |    dMdyiv=-1*D1*term1-D2*(term2+term3);
29 |endfunction
30 |function dMdyipiv=dMdyipi(y,Q,D1,D2,B,m1,m2)
31 |    term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
32 |    term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
33 |    term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
34 |    dMdyipiv=-D1*term1-D2*(term2+term3);
35 |endfunction

```

We will be utilising m_1 equals to zero, m_2 equals to zero for our problem but still we can use this subroutines or functions for our problem. So this is hydraulic radius, this is dR by dy again.

(Refer Slide Time: 01:51)

```

1 |clear
2 |clear
3 |function Av=areav(y,B,m1,m2)
4 |    Av=B*y+(1/2)*(m1+m2)*y^2;
5 |endfunction
6 |function dAv=dareav(y,B,m1,m2)
7 |    dAv=B+(m1+m2)*y;
8 |endfunction
9 |function Rv=HRV(y,B,m1,m2)
10 |    Rv=(B*y^(1/2)*(m1+m2)*y^2)/(B+(sqrt(1+m1^2)+sqrt(1+m2^2))*y);
11 |endfunction
12 |function dRv=dHRV(y,B,m1,m2)
13 |    Tw=B*(m1+m2)*y;
14 |    Pm=B*(sqrt(1+m1^2)+sqrt(1+m2^2))*y;
15 |    Rh=HRV(y,B,m1,m2);
16 |    dPdy=(sqrt(1+m1^2)+sqrt(1+m2^2));
17 |    dRv=(Tw/Pm)-(Rh/Pm)*dPdy;
18 |endfunction
19 |
20 |function M1iv=M1i(y1,Q1,y2,Q2,zv1,zv2,D1,D2,B,m1,m2)
21 |    M1iv=(y2-y1)+(zv2-zv1)+D1*(Q2^2*areav(y2,B,m1,m2)^(-2)-Q1^2*areav(y1,B,m1,m2)^(-2))+D2*(Q2*abs(Q2)*HRV(y2,
22 |    B,m1,m2)^(-4/3)*areav(y2,B,m1,m2)^(-2)+Q1*abs(Q1)*HRV(y1,B,m1,m2)^(-4/3)*areav(y1,B,m1,m2)^(-2));
23 |endfunction
24 |function dMdyiv=dMdyi(y,Q,D1,D2,B,m1,m2)
25 |    term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
26 |    term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
27 |    term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
28 |    dMdyiv=-1*D1*term1-D2*(term2+term3);
29 |endfunction
30 |function dMdyipiv=dMdyipi(y,Q,D1,D2,B,m1,m2)
31 |    term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
32 |    term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
33 |    term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
34 |    dMdyipiv=-D1*term1-D2*(term2+term3);
35 |endfunction

```

Now this one is a $M L i$, this is $dM L i$ divided by $dy i$ or $dy L i$. Now interesting thing in this $M L i$ is that for Q_2 square we are not changing Q_2 into $abs Q_2$. Q_1 square we are not changing it to Q_1 into $abs A_2$ but for friction slope this is changed to Q_2 into $abs Q_2$. This is again Q_1 into $abs Q_1$. In dM by dy this is the terms which are related to frictions slope. I have changed those values to Q into $abs Q$. This is Q into $abs Q$.

(Refer Slide Time: 03:05)

```

1 clear
2 function Av=areav(y,B,m1,m2)
3   Av=B*y+(1/2)*(m1+m2)*y^2;
4 endfunction
5 function dAv=dareav(y,B,m1,m2)
6   dAv=B+(m1+m2)*y;
7 endfunction
8 function Rv=HRV(y,B,m1,m2)
9   Rv=(B*y+(1/2)*(m1+m2)*y^2)/(B+(sqrt(1+m1^2)+sqrt(1+m2^2))*y);
10 endfunction
11 function dRv=dHRV(y,B,m1,m2)
12   Tw=B*(m1+m2)*y;
13   Fm=B*(sqrt(1+m1^2)+sqrt(1+m2^2))*y;
14   Rh=HRV(y,B,m1,m2);
15   dPdy=(sqrt(1+m1^2)+sqrt(1+m2^2));
16   dRv=(Tw/Fm)-(Rh/Fm)*dPdy;
17 endfunction
18
19 function M1iv=M1i(y1,Q1,y2,Q2,rV1,rV2,D1,D2,B,m1,m2)
20   M1iv=(y2-y1)+(rV2-rV1)*D1*(Q2^2*areav(y2,B,m1,m2)^(-2)-Q1^2*areav(y1,B,m1,m2)^(-2))+D2*(Q2*abs(Q2)*HRV(y2,
21   B,m1,m2)^(-4/3)*areav(y2,B,m1,m2)^(-2)+Q1*abs(Q1)*HRV(y1,B,m1,m2)^(-4/3)*areav(y1,B,m1,m2)^(-2));
22 endfunction
23 function dMdyiv=dMdyi(y,Q,D1,D2,B,m1,m2)
24   term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
25   term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
26   term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
27   dMdyiv=-D1*term1-D2*(term2+term3);
28 endfunction
29 function dMdyipiv=dMdyipl(y,Q,D1,D2,B,m1,m2)
30   term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
31   term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
32   term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
33   dMdyipiv=-D1*term1-D2*(term2+term3);
34 endfunction

```

M_{1i}

$\frac{dM_{1i}}{dy_i}$

Similarly for $dM L i$ divided by $L i$ plus 1 again this is changed to Q into as Q , Q into $abs Q$. But for $dM L i$ divided by $dQ L i$ plus 1 I have changed this Q in the term 2 as $abs Q$. And $dM L i$ divided by $dQ L i$ I have changed into $abs Q$ here.

(Refer Slide Time: 03:59)

```

1 B,m1,m2)^(-4/3)*areav(y2,B,m1,m2)^(-2)+Q1*abs(Q1)*HRV(y1,B,m1,m2)^(-4/3)*areav(y1,B,m1,m2)^(-2));
2 endfunction
3 function dMdyiv=dMdyi(y,Q,D1,D2,B,m1,m2)
4   term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
5   term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
6   term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
7   dMdyiv=-D1*term1-D2*(term2+term3);
8 endfunction
9 function dMdyipiv=dMdyipl(y,Q,D1,D2,B,m1,m2)
10  term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
11  term2=2*Q*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3)*dareav(y,B,m1,m2);
12  term3=(4/3)*Q*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-7/3)*dHRV(y,B,m1,m2);
13  dMdyipiv=-D1*term1-D2*(term2+term3);
14 endfunction
15 function dMdyiv=dMdyi(y,Q,D1,D2,B,m1,m2)
16  term1=(2*Q^2/areav(y,B,m1,m2)^3)*dareav(y,B,m1,m2);
17  term2=2*abs(Q)*areav(y,B,m1,m2)^(-3)*HRV(y,B,m1,m2)^(-4/3);
18  dMdyiv=D1*term1+D2*term2;
19 endfunction
20 function dMdyiv=dMdyi(y,Q,D1,D2,B,m1,m2)
21  term1=(2*Q/areav(y,B,m1,m2)^3);
22  term2=2*abs(Q)*areav(y,B,m1,m2)^(-2)*HRV(y,B,m1,m2)^(-4/3);
23  dMdyiv=-D1*term1+D2*term2;
24 endfunction
25
26 //-----
27 // Channel Reach: Start + End -
28 // Flow Depth Condition: 1
29 // Flow Rate (Discharge) Condition: 2
30 //-----
31 // Given Data
32 g=9.81; //m/s^2
33 global('g')
34 yd=5; //m
35 Qd=250; //m^3/s

```

$\frac{dM_{1i}}{dy_{1i}}$
 $\frac{dM_{1i}}{dQ_{1i}}$
 $\frac{dM_{1i}}{dQ_{2i}}$

Now after writing these functions I can start the main program here. So channel reach, convention is that channel reach start is plus, it is ending with minus and flow depth condition 1 means that is (condi) number 1 and flow rate or discharge condition is 2.

(Refer Slide Time: 04:32)

```
3 term2=2*abs(Q)*arctan(y,B,m1,m2)^(-2)*HEV(y,B,m1,m2)^(-4/3);
4 dhdqiv=-D1*term1+D2*term2;
5 endfunction
6
7
8
9
10
11
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13
14
15
16
17
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34
35
36
37
38
39
40
41
42
43
44
45 // Channel Reach: Start + End
46 // Flow Depth Condition: 1
47 // Flow Rate (Discharge) Condition: 2
48
49
50 // Given Data
51 g=9.81; //m/s^2
52 global('g')
53 yd=5; //m
54 Qd=250; //m^3/s
55 Qu=250; //m^3/s
56 eps_max=1e-6;
57
58
59 junn=6;
60 bjn=0;
61 chln=8;
62
63 //-----Chl# | Length | Width | m1 | m2 | Segment | n | S0 | JN1 | JN2
64 chl_inf=[1 200 30 0 0 50 0.0130 0.0005 1 3
65 2 200 40 0 0 50 0.0130 0.0005 1 6
66 3 200 20 0 0 50 0.0120 0.0005 3 4
67 4 100 20 0 0 25 0.0140 0.0005 3 5 //
68 5 100 20 0 0 25 0.0130 0.0005 5 4
69 6 100 25 0 0 25 0.0130 0.0005 6 5
70 7 100 30 0 0 25 0.0140 0.0005 4 2
71 8 300 50 0 0 75 0.0140 0.0005 6 2];
72
73 jun_inf=[-99999 Qu 0.25
74 yd -Qd 0
75 -99999 -99999 0.15
76 -99999 -99999 0.05
```

Now given data g is 9 point 8 metre per second square, g is global, yd is the flow depth, Qd is 250, Qu which is specified in the upstream that is 250, epsilon max this is required for Newton Raphson iteration 1 into 10 to the power minus 6 here.

(Refer Slide Time: 04:56)

```
3 term2=2*abs(Q)*arctan(y,B,m1,m2)^(-2)*HEV(y,B,m1,m2)^(-4/3);
4 dhdqiv=-D1*term1+D2*term2;
5 endfunction
6
7
8
9
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26
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41
42
43
44
45 // Channel Reach: Start + End
46 // Flow Depth Condition: 1
47 // Flow Rate (Discharge) Condition: 2
48
49
50 // Given Data
51 g=9.81; //m/s^2
52 global('g')
53 yd=5; //m
54 Qd=250; //m^3/s
55 Qu=250; //m^3/s
56 eps_max=1e-6;
57
58
59 junn=6;
60 bjn=0;
61 chln=8;
62
63 //-----Chl# | Length | Width | m1 | m2 | Segment | n | S0 | JN1 | JN2
64 chl_inf=[1 200 30 0 0 50 0.0130 0.0005 1 3
65 2 200 40 0 0 50 0.0130 0.0005 1 6
66 3 200 20 0 0 50 0.0120 0.0005 3 4
67 4 100 20 0 0 25 0.0140 0.0005 3 5 //
68 5 100 20 0 0 25 0.0130 0.0005 5 4
69 6 100 25 0 0 25 0.0130 0.0005 6 5
70 7 100 30 0 0 25 0.0140 0.0005 4 2
71 8 300 50 0 0 75 0.0140 0.0005 6 2];
72
73 jun_inf=[-99999 Qu 0.25
74 yd -Qd 0
75 -99999 -99999 0.15
76 -99999 -99999 0.05
```

Now we have these junction numbers. So we have all total 6 junctions and 2 boundary junctions. So out of this 6 we have 2 boundary junctions. So in this case let us consider this one as red one. This is 1, this is 2. Blue ones, 1 this is 5, this is 6. So obviously if I connect it properly so this is entry exit and if I name it this is junction node number 3, 4, 5 and 6 in this case. This is node number 2 and 1, okay.

(Refer Slide Time: 06:20)

```

55 Qu=250; //m^3/s
56 eps_max=1e-6;
57
58
59 junn=6;
60 bjn=2;
61 chln=8;
62 //-----Chl# | Length | Width | m1 | m2 | Segment | n | S0 | JN1 | JN2
63 chl_inf=[1 200 30 0 0 50 0.0130 0.0005 1 3
64          2 200 40 0 0 50 0.0130 0.0005 1 6
65          3 200 20 0 0 50 0.0120 0.0005 3 4
66          4 100 20 0 0 25 0.0140 0.0005 3 5 //
67          5 100 20 0 0 25 0.0130 0.0005 5 4
68          6 100 25 0 0 25 0.0130 0.0005 6 5
69          7 100 30 0 0 25 0.0140 0.0005 4 2
70          8 300 50 0 0 75 0.0140 0.0005 6 2];
71
72 jun_inf=[-99999 Qu 0.25
73          yd -Qd 0
74          -99999 -99999 0.15
75          -99999 -99999 0.05
76          -99999 -99999 0.1
77          -99999 -99999 0.15];
78 //0: Not Connected
79 //Positive Sign: 1st section of the l-th channel reach is connected
80 //Negative Sign: Nl+1-th section of the l-th channel reach is connected
81 jun_con=[2 1 2 0
82          2 -7 -8 0
83          3 -1 3 4
84          3 -3 -5 7
85          3 -4 -6 5
86          3 -2 6 8];
87
88 alpha=ones(chln,1);
  
```

Let us see how we can utilise this during our programming. This is channel in matrix. This is channel, this is junction information matrix. First column is your specified depth conditions, second column is specified, this is 1 2 for discharge and third one this is for elevation.

(Refer Slide Time: 06:54)

```

81 jun_con=[2 1 2 0
82          2 -7 -8 0
83          3 -1 3 4
84          3 -3 -5 7
85          3 -4 -6 5
86          3 -2 6 8];
87
88 alpha=ones(chln,1);
89
90 //Derived Information
91 Lx=chl_inf(1:chln,2);
92 B=chl_inf(1:chln,3);
93 m1=chl_inf(1:chln,4);
94 m2=chl_inf(1:chln,5);
  
```

Now for this one if I consider here we have this junction connectivity. Then alpha values, alpha values once in to channel number comma 1. That is for each channel reach we have considered alpha equals to 1. Now I can transfer these values directly to Lx. Lx is the second column, B is the third, m1 is the fourth, m2 is the fifth, Lx is sixth, n is seventh, S not is eight

one. Now after transferring these values I can calculate this mnode. Mnode is Lx divided by ΔLx plus 1. So number of segments plus 1.

(Refer Slide Time: 08:02)

```

95  n=ch_inf(1:chln,7);
96  n=ch_inf(1:chln,7);
97  S0=ch_inf(1:chln,8);
98
99  //Calculated
100 mnode=Lx./delta_x+1;
101
102 //z values
103 for l=1:chln
104   if(jun_inf(chl_inf(l,9),3) > jun_inf(chl_inf(l,10),3)) then
105     fact=-1;
106   else
107     fact=+1;
108   end
109   zv(1,1)=jun_inf(chl_inf(l,9),3);
110   for i=2:mnode(l)
111     zv(1,i)=zv(1,i-1)+fact*S0(i)*delta_x(1);
112   end
113 end
114
115
116 -----Problem Dependent Parameters-----
117 yv=yd*ones(sum(mnode),1);
118 Qv=Qd*ones(sum(mnode),1);
119
120 //General variable with y and Q
121 gv=zeros(2*sum(mnode)+1,1);
122
123 //General Identification Matrix
124 idv=y;
125 for l=1:chln
126   for i=1:mnode(l)
127     idv=idv+1;
128     gid(l,i)=idv;
129   end
130 end
131
132 //Initial Value
133 for l=1:chln
134   for i=1:mnode(l)

```

The diagram shows a network of nodes and channels. Node 1 is at the junction point. Channels 9 and 10 are highlighted. Handwritten annotations include '9 10 JUN1 JUN2' and '2 3 4 5 6 7 8 9 10'.

Now in this case we need to calculate this z value, this is important. We have zero elevation at this junction point 1. So this is junction information and in junction information we are asking for values from third column and this is for channel information L 9. This is JN1 and JN2. We are asking information for this 9th and 10th column.

(Refer Slide Time: 08:53)

```

101
102 //z values
103 for l=1:chln
104   if(jun_inf(chl_inf(l,9),3) > jun_inf(chl_inf(l,10),3)) then
105     fact=-1;
106   else
107     fact=+1;
108   end
109   zv(1,1)=jun_inf(chl_inf(l,9),3);
110   for i=2:mnode(l)
111     zv(1,i)=zv(1,i-1)+fact*S0(i)*delta_x(1);
112   end
113 end
114
115
116 -----Problem Dependent Parameters-----
117 yv=yd*ones(sum(mnode),1);
118 Qv=Qd*ones(sum(mnode),1);
119
120 //General variable with y and Q
121 gv=zeros(2*sum(mnode)+1,1);
122
123 //General Identification Matrix
124 idv=y;
125 for l=1:chln
126   for i=1:mnode(l)
127     idv=idv+1;
128     gid(l,i)=idv;
129   end
130 end
131
132 //Initial Value
133 for l=1:chln
134   for i=1:mnode(l)

```

The diagram shows a network of nodes and channels. Node 1 is at the junction point. Channels 9 and 10 are highlighted. Handwritten annotations include '9 10 JUN1 JUN2' and '2 3 4 5 6 7 8 9 10'.

Now let us say that my channel is 1. For 1 if I take this channel information L9, I will get 1. In this case I will get 3. That means junction information 1 3. What is the elevation? This was point 25. This was having a value of point 25. Now for our problem if this upstream elevation is greater than the downstream junction elevation so obviously this is the natural flow direction.

(Refer Slide Time: 10:05)

So we will consider this factor, factor is minus 1. If the elevation is decreasing obviously I should multiply this factor with S not into delta x so that I can reduce this value here. So starting with this elevation which is channel information L9 3 that means from junction information matrix from third column I am considering that at the first node what is the elevation. That is L1. Is that elevation? Now whether I should reduce it now for consecutive section or I should increase to get the downstream section.

So downstream node maybe at a higher elevation or at a lower elevation depending on the direction of flow under consideration. So in this case negative means we are considering as per our channel bed slope. And if we have considered the flow from 3 to 1 here. This is 1 this is 2, 3 to 1 here so obviously natural one was 1 to 3 this will be 3 to 1 so obviously this is at a lower elevation, this is at a higher elevation.

(Refer Slide Time: 11:58)

```

101
102 //z values
103 for l=1:chln
104     if (jun_inf(chl_inf(1,9),3) > jun_inf(chl_inf(1,10),3)) then
105         fact=-1;
106     else
107         fact=+1;
108     end
109     zv(1,i)=jun_inf(chl_inf(1,9),3);
110     for i=2:mnode(1)
111         zv(1,i)=zv(1,i-1)+fact*50(1)*delta_x(1);
112     end
113 end
114
115 -----Problem Dependent Parameters-----
116 yv=yd*ones(sum(mnode),1);
117 Qv=Qd*ones(sum(mnode),1);
118
119
120 //General variable with y and Q
121 gv=zeros(2*sum(mnode)+1,1);
122
123 //General Identification Matrix
124 idv=0;
125 for l=1:chln
126     for i=1:mnode(1)
127         idv=idv+1;
128         gid(1,i)=idv;
129     end
130 end
131
132 //Initial Value
133 for l=1:chln
134     for i=1:mnode(1)

```

So I should start from 3 and I should increase the section elevation by S not into delta x. So like that I can calculate the z values for different sections for different reaches. Now in this case after calculating the z values I can assign initial guess value for yv and Qv. This is similar to our previous code that we have utilised in our previous lecture class. But just see this numbers so we have sum into mnode. Sum into mnode considers all sections for all channel reaches. Qv also considers all sections and all channel reaches.

(Refer Slide Time: 12:54)

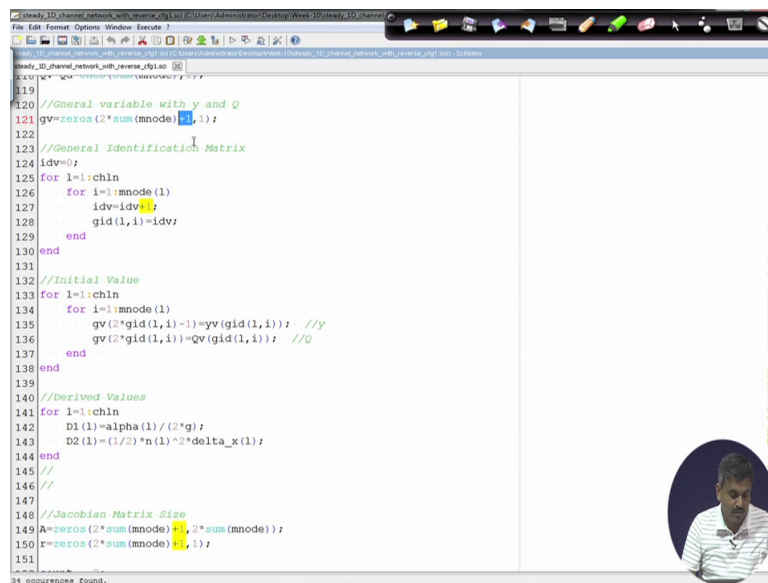
```

113 end
114
115 -----Problem Dependent Parameters-----
116 yv=yd*ones(sum(mnode),1);
117 Qv=Qd*ones(sum(mnode),1);
118
119
120 //General variable with y and Q
121 gv=zeros(2*sum(mnode)+1,1);
122
123 //General Identification Matrix
124 idv=0;
125 for l=1:chln
126     for i=1:mnode(1)
127         idv=idv+1;
128         gid(1,i)=idv;
129     end
130 end
131
132 //Initial Value
133 for l=1:chln
134     for i=1:mnode(1)
135         gv(2*gid(1,i)-1)=yv(gid(1,i)); //y
136         gv(2*gid(1,i))=Qv(gid(1,i)); //Q
137     end
138 end
139
140 //Derived Values
141 for l=1:chln
142     D1(l)=alpha(1)/(2*g);
143     D2(l)=(1/2)*n(1)^2*delta_x(1);
144 end
145 //
146 //

```

Now in this case we have a general variable which is gv and gv should be 2 into sum mnode and we can consider this as 2 into sum mnode as unknowns.

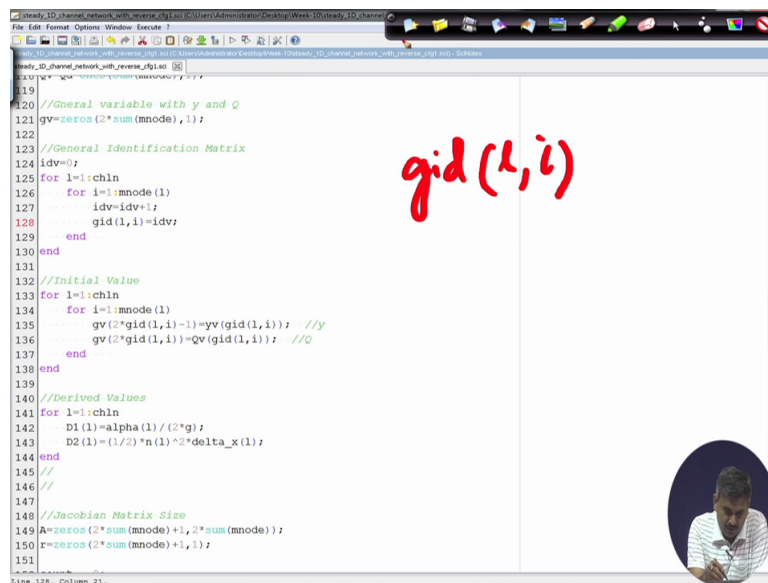
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```
119
120 //General variable with y and Q
121 gv=zeros(2*sum(mnode),1);
122
123 //General Identification Matrix
124 idv=0;
125 for l=1:chn
126     for i=1:mnode(l)
127         idv=idv+1;
128         gid(l,i)=idv;
129     end
130 end
131
132 //Initial Value
133 for l=1:chn
134     for i=1:mnode(l)
135         gv(2*gid(l,i)-1)=yv(gid(l,i)); //y
136         gv(2*gid(l,i))=Qv(gid(l,i)); //Q
137     end
138 end
139
140 //Derived Values
141 for l=1:chn
142     D1(l)=alpha(l)/(2*g);
143     D2(l)=(1/2)*n(l)^2*delta_x(l);
144 end
145 //
146 //
147
148 //Jacobian Matrix Size
149 A=zeros(2*sum(mnode)+2*sum(mnode));
150 r=zeros(2*sum(mnode)+1,1);
151
```

Now in this case we need to define general identification matrix and as per our convention. This general identification matrix is similar to the matrix we have discussed in our previous lecture class which is $gid(L, i)$. This is for L th channel and i th section.

(Refer Slide Time: 13:58)



```
119
120 //General variable with y and Q
121 gv=zeros(2*sum(mnode),1);
122
123 //General Identification Matrix
124 idv=0;
125 for l=1:chn
126     for i=1:mnode(l)
127         idv=idv+1;
128         gid(l,i)=idv;
129     end
130 end
131
132 //Initial Value
133 for l=1:chn
134     for i=1:mnode(l)
135         gv(2*gid(l,i)-1)=yv(gid(l,i)); //y
136         gv(2*gid(l,i))=Qv(gid(l,i)); //Q
137     end
138 end
139
140 //Derived Values
141 for l=1:chn
142     D1(l)=alpha(l)/(2*g);
143     D2(l)=(1/2)*n(l)^2*delta_x(l);
144 end
145 //
146 //
147
148 //Jacobian Matrix Size
149 A=zeros(2*sum(mnode)+1,2*sum(mnode));
150 r=zeros(2*sum(mnode)+1,1);
151
```

So we will have unique number for this one gid and we can utilise this information for construction of Jacobian matrix. Now this is the initial value. We can assign these initial values. the y information we can transfer it to 2 into gid into minus 1. So we (ha) have arranged this $y_1 Q_1, y_2 Q_2$. So in this particular case for each channel sections or channel reaches we have 5 sections.

Now all total we will have 1 to 40. So 1 will be the starting gid and ending value will be 40. Depending on the flow direction we can change the numbers but the total number of gid or unique ID that will be up to 40.

(Refer Slide Time: 15:10)

```

127     idv=idv+1;
128     gid(1,i)=idv;
129     end
130 end
131
132 //Initial Value
133 for l=1:chln
134     for i=1:mnode(l)
135         gv(2*gid(l,i)-1)=yv(gid(l,i)); //y
136         gv(2*gid(l,i))=Qv(gid(l,i)); //Q
137     end
138 end
139
140 //Derived Values
141 for l=1:chln
142     D1(l)=alpha(l)/(2*g);
143     D2(l)=(1/2)*n(l)^2*delta_x(l);
144 end
145 //
146 //
147
148 //Jacobian Matrix Size
149 A=zeros(2*sum(mnode)+1,2*sum(mnode));
150 r=zeros(2*sum(mnode)+1,1);
151
152 count = 0;
153 rmse=1;
154 //Space Loop
155 while rmse > eps_max
156     rmse=0;
157     eqn=0; //Equation Number
158
159     //Equations Corresponding to Segments (2N1+2N2+2N3+2N4)
160     for l=1:chln

```

Now derived values we can calculate this D1 D2 in this case. And in this case we will get eqn equals to 80 plus 1 where 40 into 2 plus 1 unknown. For 1 unknown also we will get equation but we have utilised Qu as specified value in our case. So we have only 80 unknowns in terms of y and Q values. But equation number will be of 81.

(Refer Slide Time: 16:04)

```

136         gv(2*gid(l,i))=Qv(gid(l,i)); //Q
137     end
138 end
139
140 //Derived Values
141 for l=1:chln
142     D1(l)=alpha(l)/(2*g);
143     D2(l)=(1/2)*n(l)^2*delta_x(l);
144 end
145 //
146 //
147
148 //Jacobian Matrix Size
149 A=zeros(2*sum(mnode)+1,2*sum(mnode));
150 r=zeros(2*sum(mnode)+1,1);
151
152 count = 0;
153 rmse=1;
154 //Space Loop
155 while rmse > eps_max
156     rmse=0;
157     eqn=0; //Equation Number
158
159     //Equations Corresponding to Segments (2N1+2N2+2N3+2N4)
160     for l=1:chln
161         for i=1:mnode(l)-1
162             //Continuity
163             eqn=eqn+1;
164             A(eqn,2*gid(l,i)-1)=0; //y1
165             A(eqn,2*gid(l,i))=-1; //q1
166             A(eqn,2*gid(l,i+1)-1)=0; //y1p1
167             A(eqn,2*gid(l,i+1))=1; //q1p1
168             r(eqn)=0;
169         end
170     end
171 //Momentum

```

Now I will discuss how to solve this problem. Now in this case this is count equals to zero, rmse equals to 1 and after entering into the loop I have changed it into rmse equals to zero. Equation number starts with a zero value for each channel reach because we have 2N1, 2N2, 2N3, 2N4 plus 2N5 plus 2N6 plus 2N7 plus 2N8.

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```

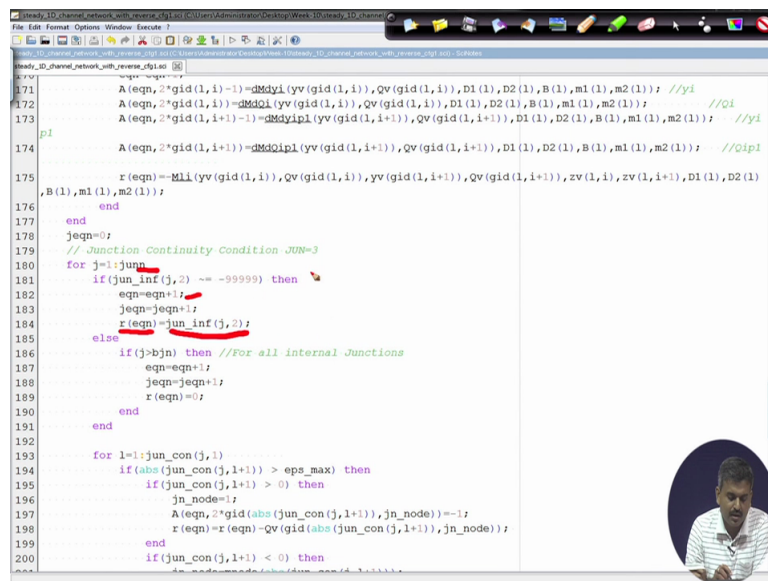
148 //Jacobian Matrix Size
149 A=zeros(2*sum(mnode)+1,2*sum(mnode));
150 r=zeros(2*sum(mnode)+1,1);
151
152 count = 0;
153 rmse=1;
154 //Space Loop
155 while rmse > eps_max
156     rmse=0;
157     eqn=0; //Equation Number
158
159     //Equations Corresponding to Segments (2N1+2N2+2N3+2N4 + 2N5 + 2N6 + 2N7 + 2N8)
160     for l=1:chln
161         for i=1:mnode(l)-1
162             //Continuity
163             eqn=eqn+1;
164             A(eqn,2*gid(l,i)-1)=0; //yi
165             A(eqn,2*gid(l,i))=-1; //oi
166             A(eqn,2*gid(l,i+1)-1)=0; //yip1
167             A(eqn,2*gid(l,i+1))=1; //oip1
168             r(eqn)=0;
169             //Momentum
170             eqn=eqn+1;
171             A(eqn,2*gid(l,i)-1)=-mdoio(yv(gid(l,i)),Qv(gid(l,i)),D1(l),D2(l),B(l),m1(l),m2(l)); //yi
172             A(eqn,2*gid(l,i))=-mdoio(yv(gid(l,i)),Qv(gid(l,i)),D1(l),D2(l),B(l),m1(l),m2(l)); //oi
173             A(eqn,2*gid(l,i+1)-1)=-mdoio(yv(gid(l,i+1)),Qv(gid(l,i+1)),D1(l),D2(l),B(l),m1(l),m2(l)); //yip1
174             A(eqn,2*gid(l,i+1))=-mdoio(yv(gid(l,i+1)),Qv(gid(l,i+1)),D1(l),D2(l),B(l),m1(l),m2(l)); //oip1
175             r(eqn)=-Mii(yv(gid(l,i)),Qv(gid(l,i)),yv(gid(l,i+1)),Qv(gid(l,i+1)),zv(l,i),zv(l,i+1),D1(l),D2(l),B(l),m1(l),m2(l));
176         end
177     end
178     iean=0;

```

Now after generating these many 64 equations I can start including the junction continuity conditions. So junction continuity condition for each junction there will be one condition. So j equals to junction number. For each junction number we have one condition. This junction information j2 which is the second column this is not equal to minus 999 5 9s.

So that means we have a specified value present there then we can add that for equation number. Equation number equals to eqn plus 1 and this is a junction equation number. This is r equation number equals to junction information j2. That means we are directly specifying r or right hand side equals to that specified value.

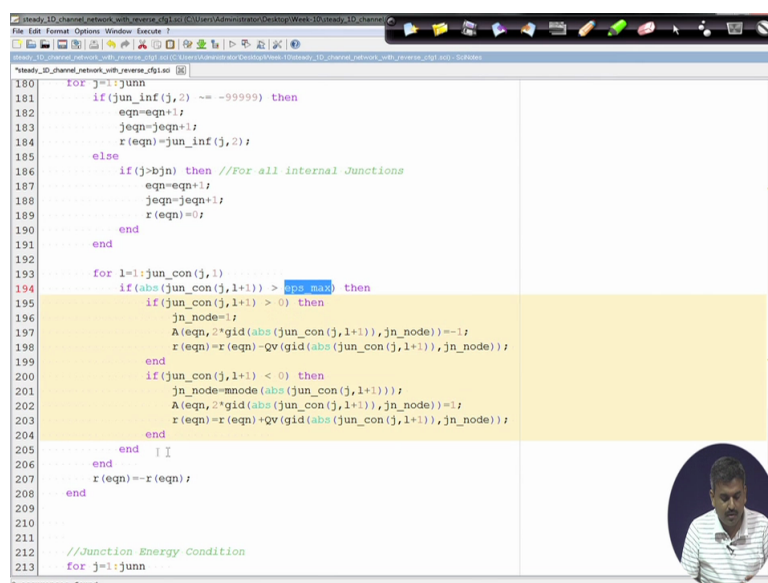
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```
171 A(eqn,2*gid(1,i)-1)=dmdy1(yv(gid(1,i)),Qv(gid(1,i)),D1(1),D2(1),B(1),m1(1),m2(1)); //y1
172 A(eqn,2*gid(1,i))=dmdQ1(yv(gid(1,i)),Qv(gid(1,i)),D1(1),D2(1),B(1),m1(1),m2(1)); //Q1
173 A(eqn,2*gid(1,i)+1)=dmdy1(yv(gid(1,i+1)),Qv(gid(1,i+1)),D1(1),D2(1),B(1),m1(1),m2(1)); //y1
174
175 p1
176 A(eqn,2*gid(1,i+1))=dmdQ1(yv(gid(1,i+1)),Qv(gid(1,i+1)),D1(1),D2(1),B(1),m1(1),m2(1)); //Q1
177
178 r(eqn)=-M1(yv(gid(1,i)),Qv(gid(1,i)),yv(gid(1,i+1)),Qv(gid(1,i+1)),zv(1,i),zv(1,i+1),D1(1),D2(1),
179 B(1),m1(1),m2(1));
180
181 end
182 jeqn=0;
183 // Junction Continuity Condition JUN=3
184 for j=1:junn
185     if(jun_inf(j,2) ~= -99999) then
186         eqn=eqn+1;
187         jeqn=jeqn+1;
188         r(eqn)=jun_inf(j,2);
189     else
190         if(j>bjn) then //For all internal Junctions
191             eqn=eqn+1;
192             jeqn=jeqn+1;
193             r(eqn)=0;
194         end
195     end
196
197 for l=1:jun_con(j,1)
198     if(abs(jun_con(j,l+1)) > eps_max) then
199         if(jun_con(j,l+1) > 0) then
200             j_n_node=1;
201             A(eqn,2*gid(abs(jun_con(j,l+1)),j_n_node))=-1;
202             r(eqn)=r(eqn)-Qv(gid(abs(jun_con(j,l+1)),j_n_node));
203         end
204         if(jun_con(j,l+1) < 0) then
205             j_n_node=mnode(abs(jun_con(j,l+1)));
206             A(eqn,2*gid(abs(jun_con(j,l+1)),j_n_node))=1;
207             r(eqn)=r(eqn)+Qv(gid(abs(jun_con(j,l+1)),j_n_node));
208         end
209     end
210 end
211
212 //Junction Energy Condition
213 for j=1:junn
```

Now after specifying that value we need to consider starting from L equals to 1 to junction continuity j1. That is first column contains the number of channels present in the junction. So in this case we will get or we have to add these values. If abs junction condition, if absolute value of junction condition L plus 1 starting from the second column we can extract the information about junction connectivity. And this is epsilon max. Obviously if zero value is specified so this condition will not be satisfied.

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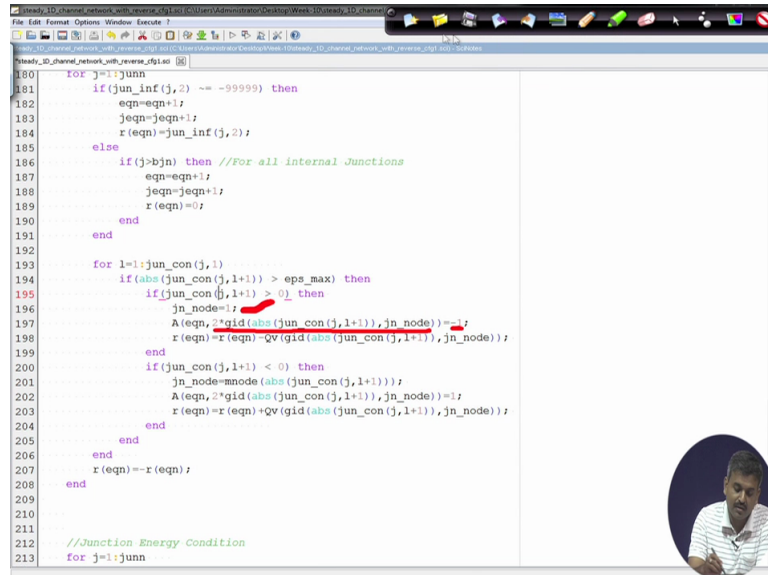


```
180 for j=1:junn
181     if(jun_inf(j,2) ~= -99999) then
182         eqn=eqn+1;
183         jeqn=jeqn+1;
184         r(eqn)=jun_inf(j,2);
185     else
186         if(j>bjn) then //For all internal Junctions
187             eqn=eqn+1;
188             jeqn=jeqn+1;
189             r(eqn)=0;
190         end
191     end
192
193 for l=1:jun_con(j,1)
194     if(abs(jun_con(j,l+1)) > eps_max) then
195         if(jun_con(j,l+1) > 0) then
196             j_n_node=1;
197             A(eqn,2*gid(abs(jun_con(j,l+1)),j_n_node))=-1;
198             r(eqn)=r(eqn)-Qv(gid(abs(jun_con(j,l+1)),j_n_node));
199         end
200         if(jun_con(j,l+1) < 0) then
201             j_n_node=mnode(abs(jun_con(j,l+1)));
202             A(eqn,2*gid(abs(jun_con(j,l+1)),j_n_node))=1;
203             r(eqn)=r(eqn)+Qv(gid(abs(jun_con(j,l+1)),j_n_node));
204         end
205     end
206 end
207
208 r(eqn)=-r(eqn);
209
210 end
211
212 //Junction Energy Condition
213 for j=1:junn
```

Now if junction continuity j L plus 1 this is greater than zero. Obviously if it is greater than zero that means we are starting from the starting node. That means j underscore node this is 1

and we can specify this condition and this should be negative because we are starting at that junction. So it should be negative discharge value as per our convention.

(Refer Slide Time: 19:52)



```
180     for j=1:junn
181         if(jun_inf(j,2) == -99999) then
182             eqn=eqn+1;
183             jeqn=jeqn+1;
184             r(eqn)=jun_inf(j,2);
185         else
186             if(j>bjn) then //For all internal Junctions
187                 eqn=eqn+1;
188                 jeqn=jeqn+1;
189                 r(eqn)=0;
190             end
191         end
192
193         for l=1:jun_con(j,1)
194             if(abs(jun_con(j,l+1)) > eps_max) then
195                 if(jun_con(j,l+1) > 0) then
196                     jn_node=1;
197                     A(eqn,2*gid(abs(jun_con(j,l+1)),jn_node))=-1;
198                     r(eqn)=r(eqn)-Qv(gid(abs(jun_con(j,l+1)),jn_node));
199                 end
200                 if(jun_con(j,l+1) < 0) then
201                     jn_node=mnode(abs(jun_con(j,l+1)));
202                     A(eqn,2*gid(abs(jun_con(j,l+1)),jn_node))=1;
203                     r(eqn)=r(eqn)+Qv(gid(abs(jun_con(j,l+1)),jn_node));
204                 end
205             end
206         end
207         r(eqn)=-r(eqn);
208     end
209
210
211 //Junction Energy Condition
212 for j=1:junn
213
```

This junction connectivity if this is negative so obviously we are talking about the terminating node here. So junction node equals to mnode absolute junction connectivity jL plus 1 and we are adding discharge to our junction. So that is why coefficient is 1 and this is r eqn plus Qv in this case. Interesting part is that if this junction condition is not specified here obviously j greater than bjn .

Bjn means number of boundary junctions. If j value crosses for boundary junctions then we should start calculating the discharge conditions for other nodes.

(Refer Slide Time: 20:54)

```
180 for j=1:junn
181     if (jun_inf(j,2) == -99999) then
182         eqn=eqn+1;
183         jeqn=jeqn+1;
184         r(eqn)=jun_inf(j,2);
185     else
186         if (j>bjn) then //For all internal Junctions
187             eqn=eqn+1;
188             jeqn=jeqn+1;
189             r(eqn)=0;
190         end
191     end
192
193     for l=1:jun_con(j,1)
194         if (abs(jun_con(j,1+l)) > eps_max) then
195             if (jun_con(j,1+l) > 0) then
196                 jn_node=1;
197                 A(eqn,2*gid(abs(jun_con(j,1+l)),jn_node))=-1;
198                 r(eqn)=r(eqn)-Qv(gid(abs(jun_con(j,1+l)),jn_node));
199             end
200             if (jun_con(j,1+l) < 0) then
201                 jn_node=mnode(abs(jun_con(j,1+l)));
202                 A(eqn,2*gid(abs(jun_con(j,1+l)),jn_node))=1;
203                 r(eqn)=r(eqn)+Qv(gid(abs(jun_con(j,1+l)),jn_node));
204             end
205         end
206     end
207     r(eqn)=r(eqn);
208 end
209
210
211
212 //Junction Energy Condition
213 for j=1:junn
```

So in this case r_{eqn} equals to zero in this case. At the end we should write r_{eqn} equals to minus r_{eqn} . Obviously minus of function value is required on the right hand side. That is why I have written it. Now let us consider junction energy condition. Energy condition if some value is specified if junction information j_1 this value is not equal to minus 5 9s then eqn equals to eqn plus 1. And if it is positive first node, in the second column if it is negative obviously it is $mnode$. So accordingly we can specify our conditions.

(Refer Slide Time: 22:05)

```
208     end
209
210
211 //Junction Energy Condition
212 for j=1:junn
213
214     if (jun_inf(j,1) == -99999) then
215         eqn=eqn+1;
216         if (jun_con(j,2) > 0) then jn_node1=1; end
217         if (jun_con(j,2) < 0) then jn_node1=mnode(abs(jun_con(j,2))); end
218         A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
219         r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1))-jun_inf(j,1);
220         r(eqn)=r(eqn);
221     end
222
223     if (jun_con(j,1) > 1) then
224         for l=1:jun_con(j,1)-1
225             eqn=eqn+1;
226             if (jun_con(j,2) > 0) then jn_node1=1; end
227             if (jun_con(j,2) < 0) then jn_node1=mnode(abs(jun_con(j,2))); end
228             A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
229             r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1));
230
231             if (jun_con(j,1+2) > 0) then jn_node2=1; end
232             if (jun_con(j,1+2) < 0) then jn_node2=mnode(abs(jun_con(j,1+2))); end
233             A(eqn,2*gid(abs(jun_con(j,1+2)),jn_node2)-1)=1;
234             r(eqn)=r(eqn)-yv(gid(abs(jun_con(j,1+2)),jn_node2));
235
236             r(eqn)=r(eqn);
237         end
238     end
239 end
240
```

Now after considering this we can include this junction connectivity j_1 greater than 1. If it is greater than 1 then only we should iterate. This is starting from L to junction connectivity j_1

minus 1. And this is the first node or the element which is there in the second column we will consider that as a fixed and we will start our calculation by considering the elements from the third column.

So from the third column we will get information about the starting or ending node. Accordingly we can enter the values there and finally we need to perform this operation.

(Refer Slide Time: 23:12)

```

215 if(jun_inf(j,1) ~= -99999) then
216     eqn=eqn+1;
217     if(jun_con(j,2) > 0) then jn_node1=1; end
218     if(jun_con(j,2) < 0) then jn_node1=mnode(abs(jun_con(j,2))); end
219     A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
220     r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1))-jun_inf(j,1);
221     r(eqn)=-r(eqn);
222 end
223 if(jun_con(j,1) > 1) then
224     for l=1:jun_con(j,1)-1]
225         eqn=eqn+1;
226         if(jun_con(j,2) > 0) then jn_node1=1; end
227         if(jun_con(j,2) < 0) then jn_node1=mnode(abs(jun_con(j,2))); end
228         A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
229         r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1));
230
231         if(jun_con(j,1+2) > 0) then jn_node2=1; end
232         if(jun_con(j,1+2) < 0) then jn_node2=mnode(abs(jun_con(j,1+2))); end
233         A(eqn,2*gid(abs(jun_con(j,1+2)),jn_node2)-1)=1;
234         r(eqn)=r(eqn)-yv(gid(abs(jun_con(j,1+2)),jn_node2));
235
236         r(eqn)=-r(eqn);
237     end
238 end
239 end
240
241 //Del y Q
242 delyQ=inv(A'*A)*(A'*r);
243
244 for i=1:2*sum(mnode)
245     gv(i)=gv(i)+delyQ(i);
246     rmse=rmse+delyQ(i)^2;
247 end
    
```

So obviously in this case we have calculated all the things. Now interesting part here is that the size is we have 81 equations but we have our 80 unknowns because I have already specified Qu value there. So in this case this is del yQ which is of size 80 into 1 and right hand side is r again 81 into 1.

(Refer Slide Time: 24:02)

```

219     A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
220     r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1))-jun_inf(j,1);
221     r(eqn)=-r(eqn);
222     end
223     if(jun_con(j,1) > 1) then
224         for l=1:jun_con(j,1)-1]
225             eqn=eqn+1;
226             if(jun_con(j,2) > 0) then jn_node1=1; end
227             if(jun_con(j,2) < 0) then jn_node1=mnode(abs(jun_con(j,2))); end
228             A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
229             r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1));
230             r(eqn)=-r(eqn);
231             if(jun_con(j,1+2) > 0) then jn_node2=1; end
232             if(jun_con(j,1+2) < 0) then jn_node2=mnode(abs(jun_con(j,1+2))); end
233             A(eqn,2*gid(abs(jun_con(j,1+2)),jn_node2)-1)=1;
234             r(eqn)=r(eqn)-yv(gid(abs(jun_con(j,1+2)),jn_node2));
235             r(eqn)=-r(eqn);
236         end
237     end
238     end
239
240     //del y Q
241     delyQ=inv(A'*A)*(A'*r);
242
243     for i=1:2*sum(mnode)
244         gv(i)=gv(i)+delyQ(i);
245         rmse=rmse+delyQ(i)^2;
246     end
247     //Update Value
248     for l=1:chln
249         for i=1:mnode(l)
250             yv(gid(l,i))=gv(2*gid(l,i)-1);
251             con(gid(l,i))=con(2*gid(l,i)-1);

```

$$A_{81 \times 80} \Delta y_{80 \times 1} = Y_{81 \times 1}$$



What I can do? I can just multiply A transpose on both the sides so obviously this is A transpose. Now after multiplying A transpose obviously the size will be 80 into 81. So the resultant size is 80 80. Now del yQ 80 into 1 this is equals to A transpose A inverse into A transpose r. So size is 80 into 1. So after considering this, this is the calculation here.

(Refer Slide Time: 24:52)

```

219     A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
220     r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1))-jun_inf(j,1);
221     r(eqn)=-r(eqn);
222     end
223     if(jun_con(j,1) > 1) then
224         for l=1:jun_con(j,1)-1]
225             eqn=eqn+1;
226             if(jun_con(j,2) > 0) then jn_node1=1; end
227             if(jun_con(j,2) < 0) then jn_node1=mnode(abs(jun_con(j,2))); end
228             A(eqn,2*gid(abs(jun_con(j,2)),jn_node1)-1)=1;
229             r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1));
230             r(eqn)=-r(eqn);
231             if(jun_con(j,1+2) > 0) then jn_node2=1; end
232             if(jun_con(j,1+2) < 0) then jn_node2=mnode(abs(jun_con(j,1+2))); end
233             A(eqn,2*gid(abs(jun_con(j,1+2)),jn_node2)-1)=1;
234             r(eqn)=r(eqn)-yv(gid(abs(jun_con(j,1+2)),jn_node2));
235             r(eqn)=-r(eqn);
236         end
237     end
238     end
239
240     //del y Q
241     delyQ=inv(A'*A)*(A'*r);
242
243     for i=1:2*sum(mnode)
244         gv(i)=gv(i)+delyQ(i);
245         rmse=rmse+delyQ(i)^2;
246     end
247     //Update Value
248     for l=1:chln
249         for i=1:mnode(l)
250             yv(gid(l,i))=gv(2*gid(l,i)-1);
251             con(gid(l,i))=con(2*gid(l,i)-1);

```

$$A^T A_{80 \times 80} \Delta y_{80 \times 1} = A^T Y_{81 \times 1}$$

$$\Delta y_{80 \times 1} = (A^T A)^{-1} A^T Y$$

We are considering inverse of this one. Now finally we need to transfer these gv values. Gv values we should add gv previous or value del yQ i. And subsequently we need to transfer these values or update these values for next iteration. So yv should be gv in to gid minus 1 and this is yv is gv 2 gid.

(Refer Slide Time: 25:31)


```

229     A(eqn)=gid(abs(jun_con(j,2)),jn_node2)=1;
230     r(eqn)=yv(gid(abs(jun_con(j,2)),jn_node1));
231
232     if(jun_con(j,1+2) > 0) then jn_node2=1; end
233     if(jun_con(j,1+2) < 0) then jn_node2=mnode(abs(jun_con(j,1+2))); end
234     A(eqn,2*gid(abs(jun_con(j,1+2)),jn_node2)-1)=-1;
235     r(eqn)=r(eqn)-yv(gid(abs(jun_con(j,1+2)),jn_node2));
236
237     r(eqn)=-r(eqn);
238 end
239 end
240
241 //Del y Q
242 delyQ=inv(A'*A)*(A'*r);
243
244 for i=1:2*sum(mnode)
245     gv(i)=gv(i)+delyQ(i);
246     rmse=rmse+delyQ(i)^2;
247 end
248 //Update Value
249 for l=1:chln
250     for i=1:mnode(l)
251         yv(gid(l,i))=gv(2*gid(l,i)-1);
252         Qv(gid(l,i))=gv(2*gid(l,i));
253     end
254 end
255 rmse=sqrt(rmse/sum(mnode));
256 count = count + 1;
257 disp([count rmse])
258 //disp([count max(delyQ)])
259 end
260 disp(eqn)
261 //Print Output

```

Now let us run this one because last thing is rmse calculation count rmse values and final thing is print L 1 to channel number. This is channel number then section, distance, depth, discharge values.

(Refer Slide Time: 25:55)

```

238     end
239 end
240
241 //Del y Q
242 delyQ=inv(A'*A)*(A'*r);
243
244 for i=1:2*sum(mnode)
245     gv(i)=gv(i)+delyQ(i);
246     rmse=rmse+delyQ(i)^2;
247 end
248 //Update Value
249 for l=1:chln
250     for i=1:mnode(l)
251         yv(gid(l,i))=gv(2*gid(l,i)-1);
252         Qv(gid(l,i))=gv(2*gid(l,i));
253     end
254 end
255 rmse=sqrt(rmse/sum(mnode));
256 count = count + 1;
257 disp([count rmse])
258 //disp([count max(delyQ)])
259 end
260 disp(eqn)
261 //Print Output
262 for l=1:chln
263     disp(['Channel Number:' string(l)])
264     disp(['Section Distance(m) Depth(m) Discharge(m^3/s)'])
265     for i=1:mnode(l)
266         disp([i (i-1)*delta_x(l) yv(gid(l,i)) Qv(gid(l,i))])
267     end
268 end
269
270

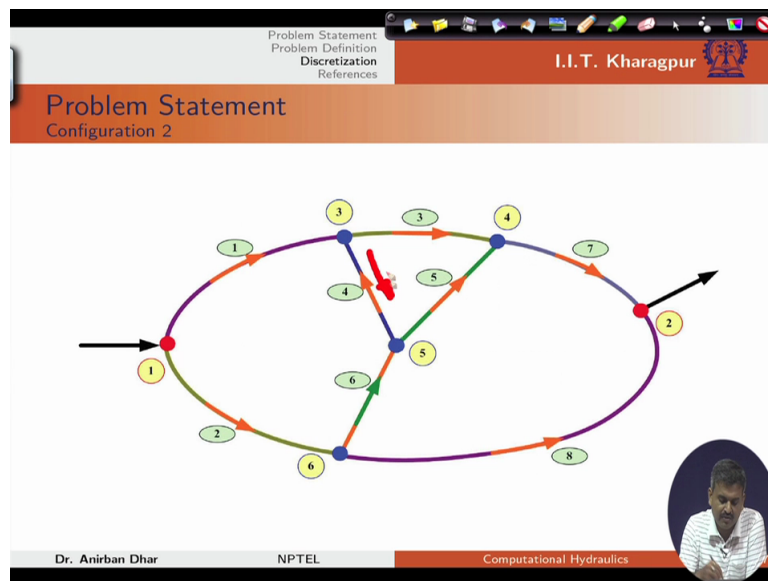
```

So if we consider these discharge values. Now if I run this what I am getting? For all sections that means whether it is depth or discharge all values are positive. So obviously y should be positive but if our direction for flow under consideration is incorrect then I should get a negative value.

In this case I can see that for first channel I am getting 97 point 74, second channel 154 point 25, third channel I am getting 55 point 09, fourth channel 40 point 65, fifth channel 52 point

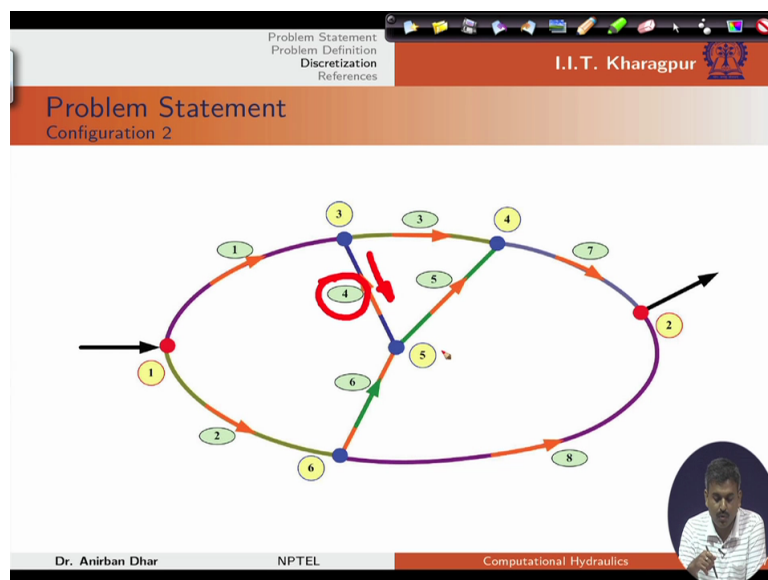
66, sixth channel 12 point 01, seventh channel 107 point 76, eight channel 142 point 23. Now if I change the direction of flow, direction of flow means if I conceptualize the problem by changing the direction of flow let us see this configuration. Now in this configuration natural gradient is in this direction.

(Refer Slide Time: 27:43)



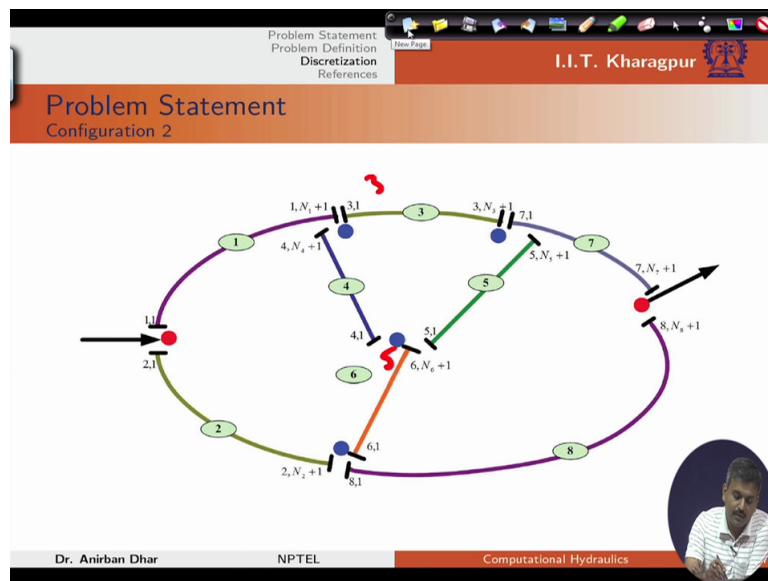
So I have kept the flow direction for all other channels that means channel 1, 2, 3, 5, 6, 7, 8 same but I have changed the direction of flow for this channel 4. That means I am considering channel is flowing from 5 to 3. Obviously 3 is higher elevation 5 is having the lower elevation in this case.

(Refer Slide Time: 28:20)



Now if the connectivity is from 5 to 3 obviously I should change my numbering or section numbering scheme. So for all other channel reaches the section numbering scheme is same. But now from 5 to 3 this is flowing so I should start channel section 1 at section or channel junction 5 and it should end at 3 with $N_4 + 1$.

(Refer Slide Time: 29:07)



Now this is a numbering scheme that means now I am considering the flow is from 1 to N4 plus 1. So that is my convention that from 1 to N4 plus 1 it should be positive. Now I have to change this channel information. In this case I have changed it to 5 3 next level. There is no change in this particular matrix but now for section or channel junction 3 this end section of channel 4 is connected. So this is minus 4, this is plus 4.

(Refer Slide Time: 30:06)

chLinf =

1	200	30	0	0	50	0.0130	0.0005	1	3
2	200	40	0	0	50	0.0130	0.0005	1	6
3	200	20	0	0	50	0.0120	0.0005	3	4
4	100	20	0	0	25	0.0140	0.0005	5	3
5	100	20	0	0	25	0.0130	0.0005	5	4
6	100	25	0	0	25	0.0130	0.0005	6	5
7	100	30	0	0	25	0.0140	0.0005	4	2
8	300	50	0	0	75	0.0140	0.0005	6	2

jun_inf =

-99999	250	0.25
5	-250	0
-99999	-99999	0.15
-99999	-99999	0.05
-99999	-99999	0.10
-99999	-99999	0.15

jun_con =

2	1	2	0
2	-7	-8	0
3	-1	3	-4
3	-3	-5	7
3	4	-6	5
3	-2	6	8

Now if I implement this same thing here so let us see what will be the problem or what will be this case? In this case obviously everything is same. Gv again I am considering 1, this is same. Only change is there this is 5 3.

(Refer Slide Time: 30:44)

```
steady_1D_channel_network_with_reversal_f12.scd
File Edit Format Options Window Execute ?
C:\Users\Administrator\Desktop\Week 10\steady_1D_channel_network_with_reversal_f12.scd
steady_1D_channel_network_with_reversal_f12.scd
1 function Q=channel(y, B, m1, m2)
2     term1=(2*Q/area(y, B, m1, m2)^3);
3     term2=2*abs(Q)*area(y, B, m1, m2)^(-2)*HRV(y, B, m1, m2)^(-4/3);
4     dmdqiv=-D1*term1+D2*term2;
5 endfunction
45 -----
46 // Channel Reach: Start + End -
47 // Flow Depth Condition: 1
48 // Flow Rate (Discharge) Condition: 2
49 -----
50 // Given Data
51 g=9.81; //m/s^2
52 global('g')
53 yd=5; //m
54 Qd=250; //m^3/s
55 Qu=250; //m^3/s
56 eps_max=1e-6;
57
58 -----
59 junn=6;
60 bjn=2;
61 chln=8;
62 //----- Ch# | Length | Width | m1 | m2 | Segment | n | S0 | JN1 | JN2 -----
63 chl_inf=[1 200 30 0 0 50 0.0130 0.0005 1 3
64          2 200 40 0 0 50 0.0130 0.0005 1 6
65          3 200 20 0 0 50 0.0120 0.0005 3 4
66          4 100 20 0 0 25 0.0140 0.0005 5 3 //
67          5 100 20 0 0 25 0.0130 0.0005 5 4
68          6 100 25 0 0 25 0.0130 0.0005 6 5
69          7 100 30 0 0 25 0.0140 0.0005 4 2
70          8 300 50 0 0 75 0.0140 0.0005 6 2];
71
72 jun_inf=[-99999 Qu 0.25
73          yd -Qd 0
74          -99999 -99999 0.15
75          -99999 -99999 0.05
76          -99999 -99999 0.1
77          -99999 -99999 0.15];
78 //0: Not Connected
79 //Positive Sign: 1st section of the 1-th channel reach is connected
80 //Negative Sign: N+1-th section of the 1-th channel reach is connected
81 jun_con=[2 1 2 0
82          2 -7 -8 0
83          3 -1 3 -4
84          3 -3 -5 -4
85          3 4 -6 5
86          3 -5 -8 8];
87
88 alpha=ones(chln,1);
89
90 //Derived Information
91 Lx=chl_inf(1:chln,2);
92 B=chl_inf(1:chln,3);
93 m1=chl_inf(1:chln,4);
94 m2=chl_inf(1:chln,5);
95 delta_x=chl_inf(1:chln,6);
```

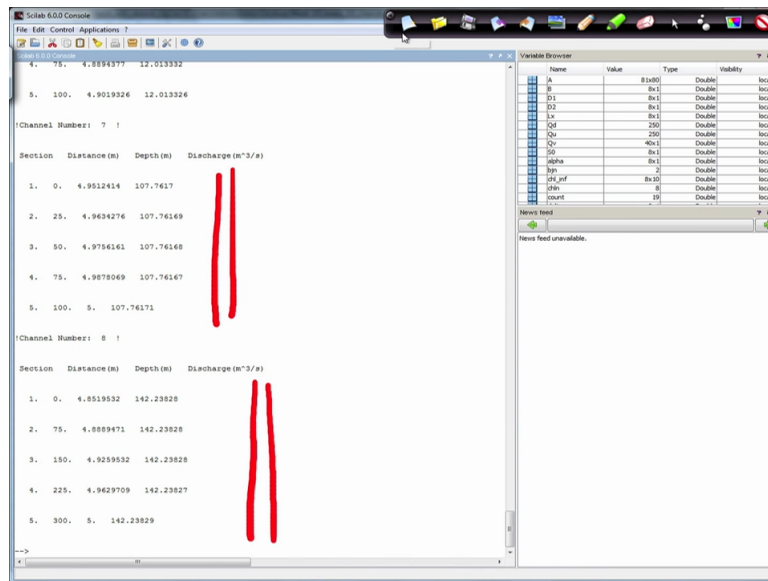
And this part this is minus 4 and 4.

(Refer Slide Time: 30:51)

```
steady_1D_channel_network_with_reversal_f12.scd
File Edit Format Options Window Execute ?
C:\Users\Administrator\Desktop\Week 10\steady_1D_channel_network_with_reversal_f12.scd
steady_1D_channel_network_with_reversal_f12.scd
62 //----- Ch# | Length | Width | m1 | m2 | Segment | n | S0 | JN1 | JN2 -----
63 chl_inf=[1 200 30 0 0 50 0.0130 0.0005 1 3
64          2 200 40 0 0 50 0.0130 0.0005 1 6
65          3 200 20 0 0 50 0.0120 0.0005 3 4
66          4 100 20 0 0 25 0.0140 0.0005 5 3 //
67          5 100 20 0 0 25 0.0130 0.0005 5 4
68          6 100 25 0 0 25 0.0130 0.0005 6 5
69          7 100 30 0 0 25 0.0140 0.0005 4 2
70          8 300 50 0 0 75 0.0140 0.0005 6 2];
71
72 jun_inf=[-99999 Qu 0.25
73          yd -Qd 0
74          -99999 -99999 0.15
75          -99999 -99999 0.05
76          -99999 -99999 0.1
77          -99999 -99999 0.15];
78 //0: Not Connected
79 //Positive Sign: 1st section of the 1-th channel reach is connected
80 //Negative Sign: N+1-th section of the 1-th channel reach is connected
81 jun_con=[2 1 2 0
82          2 -7 -8 0
83          3 -1 3 -4
84          3 -3 -5 -4
85          3 4 -6 5
86          3 -5 -8 8];
87
88 alpha=ones(chln,1);
89
90 //Derived Information
91 Lx=chl_inf(1:chln,2);
92 B=chl_inf(1:chln,3);
93 m1=chl_inf(1:chln,4);
94 m2=chl_inf(1:chln,5);
95 delta_x=chl_inf(1:chln,6);
```

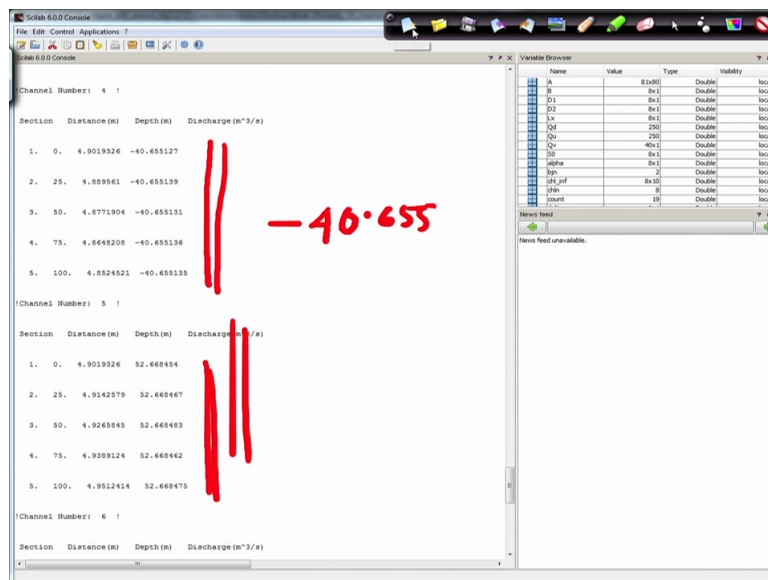
Other values are same. Now if I run it I can see that at channel 8 I am getting 142 which is the same as previous configuration. Channel 7 which is 107 this is same as previous configuration because we have considered the same direction for flow for 7 and 8.

(Refer Slide Time: 31:19)



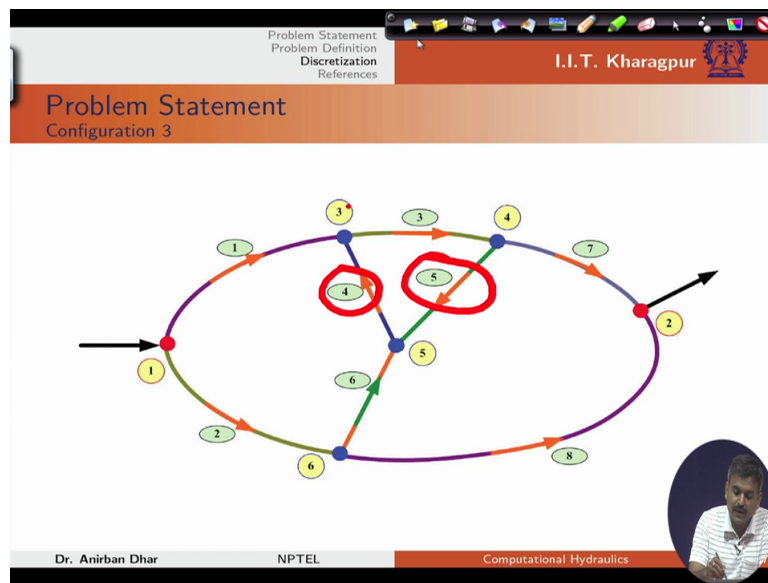
If we consider 6 this is 12 again, this is same. For channel number 5 this is 52. But interesting thing is visible for this channel number four. Here we are getting the value of minus 40 655. That means whatever flow direction I have considered for my problem that is incorrect and flow should be from 3 to 5 as I have assumed it from 5 to 3 that is not correct.

(Refer Slide Time: 32:17)



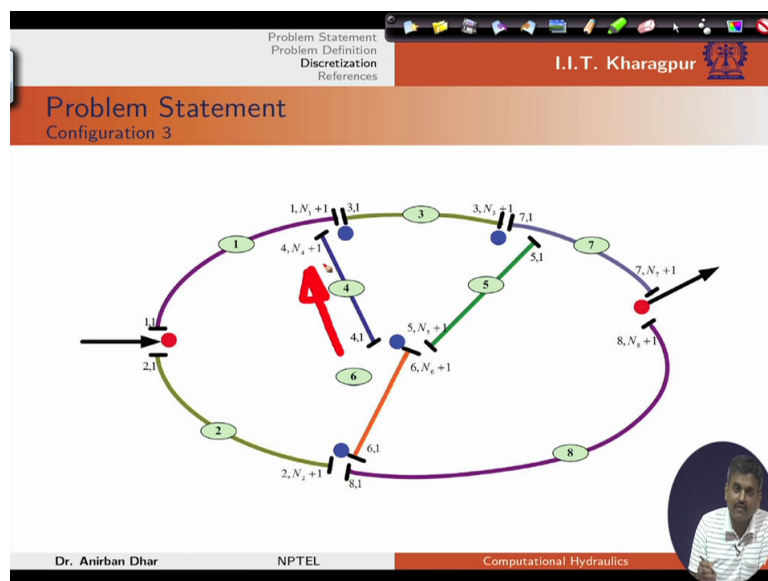
Similar thing I can extend for other channel reaches. Now let us consider or let us disturb this flow system for this channel reach 4 and 5. If I change the flow directions. Now in this case I am considering the flow is from 5 to 3 and in this case I am considering for channel reach 5 it is 4 to 5.

(Refer Slide Time: 32:54)



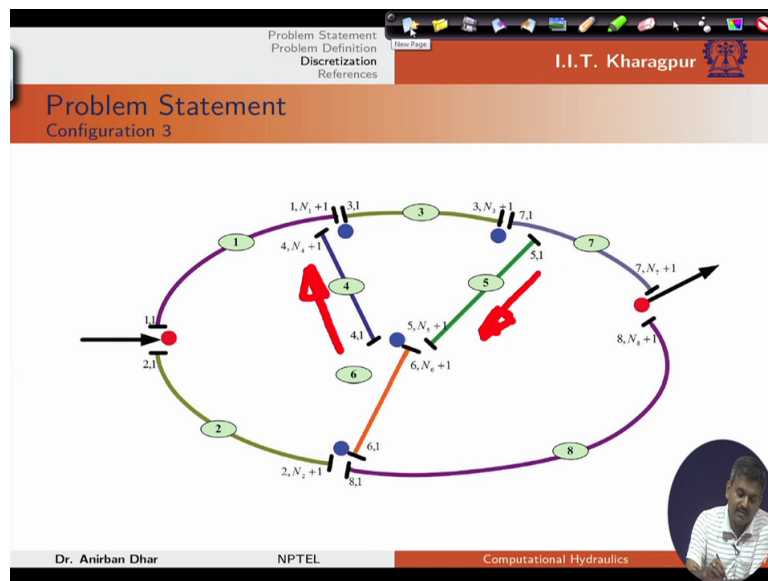
Now what will happen with this configuration? Again I need to change this section numbering scheme. So this is my direction of flow as per assumption.

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In this case this is my direction of flow for channel reach number 5. So obviously in this case I have to change this channel information matrix.

(Refer Slide Time: 33:29)



In channel information matrix I have to change these two entries. This is 5 to 3 and 4 to 5. Now flow is from 4 to 5.

(Refer Slide Time: 33:39)

chLinf =

1	200	30	0	0	50	0.0130	0.0005	1	3
2	200	40	0	0	50	0.0130	0.0005	1	6
3	200	20	0	0	50	0.0120	0.0005	3	4
4	100	20	0	0	25	0.0140	0.0005	5	3
5	100	20	0	0	25	0.0130	0.0005	4	5
6	100	25	0	0	25	0.0130	0.0005	6	5
7	100	30	0	0	25	0.0140	0.0005	4	2
8	300	50	0	0	75	0.0140	0.0005	6	2

And again I need to consider this that at channel junction 3 this end section of 4 is connected, at channel section 5 starting section of 4 is connected. Channel section 4 starting section of 5 is connected and channel junction 5 ending section of channel reach 5 is connected.

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I.I.T. Kharagpur

Program Implementation

Configuration 3

$$\text{chl_inf} = \begin{bmatrix} 1 & 200 & 30 & 0 & 0 & 50 & 0.0130 & 0.0005 & 1 & 3 \\ 2 & 200 & 40 & 0 & 0 & 50 & 0.0130 & 0.0005 & 1 & 6 \\ 3 & 200 & 20 & 0 & 0 & 50 & 0.0120 & 0.0005 & 3 & 4 \\ 4 & 100 & 20 & 0 & 0 & 25 & 0.0140 & 0.0005 & 5 & 3 \\ 5 & 100 & 20 & 0 & 0 & 25 & 0.0130 & 0.0005 & 4 & 5 \\ 6 & 100 & 25 & 0 & 0 & 25 & 0.0130 & 0.0005 & 6 & 5 \\ 7 & 100 & 30 & 0 & 0 & 25 & 0.0140 & 0.0005 & 4 & 2 \\ 8 & 300 & 50 & 0 & 0 & 75 & 0.0140 & 0.0005 & 6 & 2 \end{bmatrix}$$

$$\text{jun_inf} = \begin{bmatrix} -99999 & 250 & 0.25 \\ 5 & -250 & 0 \\ -99999 & -99999 & 0.15 \\ -99999 & -99999 & 0.05 \\ -99999 & -99999 & 0.10 \\ -99999 & -99999 & 0.15 \end{bmatrix}$$

$$\text{jun_con} = \begin{bmatrix} 2 & 1 & 2 & 0 \\ 2 & -7 & -8 & 0 \\ 3 & -1 & 3 & -4 \\ 3 & -3 & 5 & 7 \\ 3 & 4 & -6 & -5 \\ 3 & -2 & 6 & 8 \end{bmatrix}$$

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Now with this configuration let us again utilise our program for this calculation. This is configuration cfg 3. Now let us see what is the situation there? Now only change is here this is from 5 to 3 and 4 to 5. In this case minus 4, 4, this is 5, minus 5.

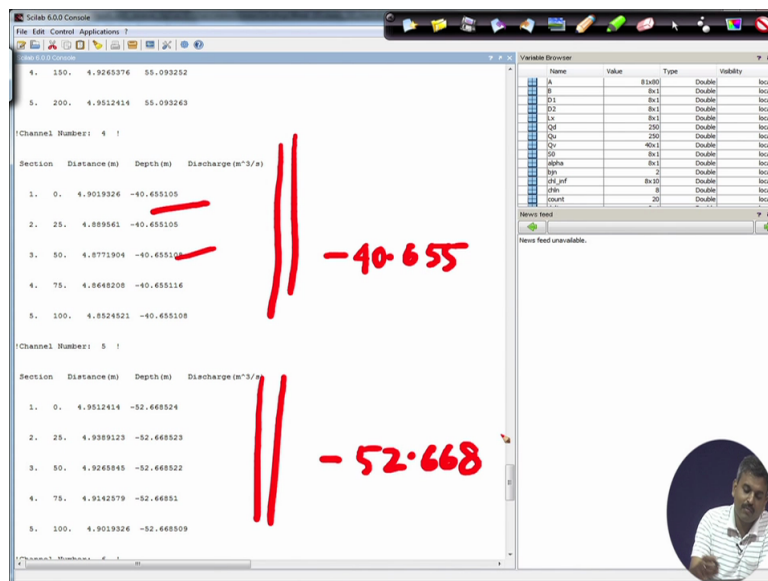
(Refer Slide Time: 34:56)

```

61 chln=0;
62 // chln=Chl# | Length | Width | m1 | m2 | Segment | n | S0 | JN1 | JN2
63 chl_inf=[1 200 30 0 0 50 0.0130 0.0005 1 3
64          2 200 40 0 0 50 0.0130 0.0005 1 6
65          3 200 20 0 0 50 0.0120 0.0005 3 4
66          4 100 20 0 0 25 0.0140 0.0005 5 3 //
67          5 100 20 0 0 25 0.0130 0.0005 4 5 //
68          6 100 25 0 0 25 0.0130 0.0005 6 5
69          7 100 30 0 0 25 0.0140 0.0005 4 2
70          8 300 50 0 0 75 0.0140 0.0005 6 2];
71
72 jun_inf=[-99999 Qu 0.25
73          yd -qd 0
74          -99999 -99999 0.15
75          -99999 -99999 0.05
76          -99999 -99999 0.1
77          -99999 -99999 0.15];
78 //0: Not Connected
79 //Positive Sign: 1st section of the l-th channel reach is connected
80 //Negative Sign: Nl+1-th section of the l-th channel reach is connected
81 jun_con=[2 1 2 0
82          2 -7 -8 0
83          3 -1 3 -4
84          3 -3 5 7
85          3 4 -6 -5
86          3 -2 6 8];
87
88 alpha=ones(chln,1);
89
90 //Derived Information
91 Lx=chl_inf(1:chln,2);
92 B=chl_inf(1:chln,3);
93 m1=chl_inf(1:chln,4);
94 m2=chl_inf(1:chln,5);
  
```

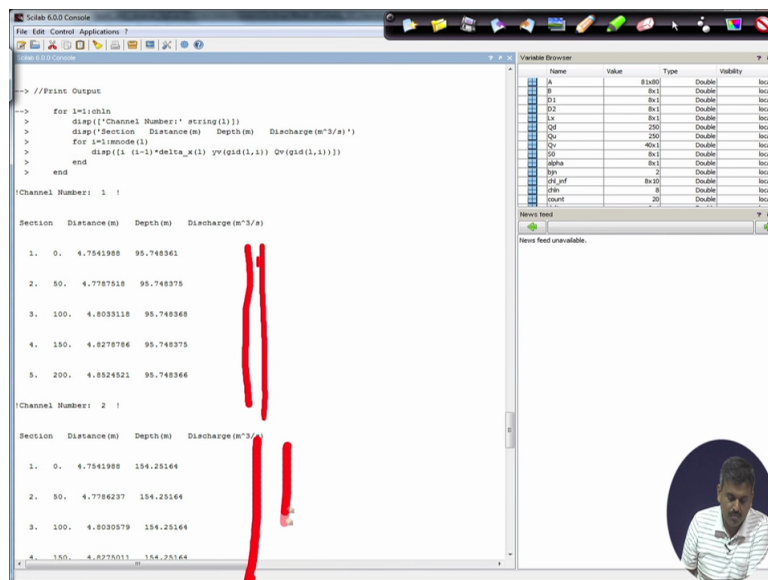
We can run this with these two changes. Interestingly I am getting the same result for 8, 7, then 6 I am getting same result and for 4 and 5 where I have change the direction of flow I am getting negative values. In this case this is 40 point 655 and this is minus 52 point 668.

(Refer Slide Time: 35:48)



So we are starting from arbitrary values without satisfying the continuity at the junction but we are getting the desired discharge and depth values. So for other channel reaches channel reach channel reach number 1, channel reach number 2 we are getting positive values because we have not changed the direction of flow in this cases.

(Refer Slide Time: 36:16)

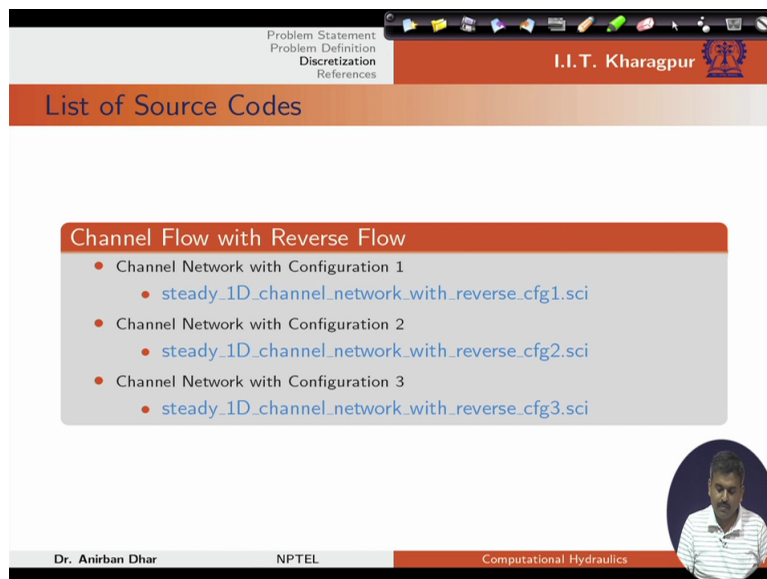


We have changed only the direction of flow for 4 and 5. Now we can say that our code can consider the reverse flow situation in steady channel flow conditions. Now this is the last configuration that we have considered. So we have considered three different configurations

and we are getting our desired value because starting point was that we have allowed the subcritical flow condition in the channel as per the slope or bed slope.

And in case of configuration 2 and 3 we have changed the flow direction and we are getting negative values because that is expected from the program for reverse flow situation. Now these are the three source codes that you can utilise to check the solutions of our channel configuration. Configuration 1, configuration 2 and configuration 3 for this loop channel network.

(Refer Slide Time: 38:12)



The screenshot shows a presentation slide with a navigation bar at the top containing 'Problem Statement', 'Problem Definition', 'Discretization', and 'References'. The slide title is 'List of Source Codes'. The main content is a box titled 'Channel Flow with Reverse Flow' containing a bulleted list of three configurations and their corresponding source code files:

- Channel Network with Configuration 1
 - [steady_1D_channel_network_with_reverse_cfg1.sci](#)
- Channel Network with Configuration 2
 - [steady_1D_channel_network_with_reverse_cfg2.sci](#)
- Channel Network with Configuration 3
 - [steady_1D_channel_network_with_reverse_cfg3.sci](#)

The slide footer includes 'Dr. Anirban Dhar', 'NPTEL', and 'Computational Hydraulics', along with a small circular portrait of the speaker.

In the next lecture I will be discussing about unsteady channel flow condition. Thank you.