TOPIC- CALCULATION OF PRE DREDGING AND POST DREDGING QUANTITIES FROM HYDROGRAPHIC SURVEY CHARTS

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Abstract: According to National Oceanographic and Atmospheric Association (NOAA), Hydrographic Survey is the branch of applied science which deals with the measurement and description of the physical features of the navigable portion of the earth's wet surface (river and ocean) and adjoining coastal areas, with special reference to their use of purpose of navigation. The Hydrographic Survey is done to estimate the quantity of material beneath the water body(river or sea) to be dredged .Calculation from pre and post hydrographic survey helps in estimating the quantity of material required to shun from the bed of water-body which cannot be physically calculated.

Introduction: During longitudinal survey or the Thalweg survey the soundings are taken along the stretch of the river in the longitudinal direction in deepest channel. Survey can be done using single beam and Multibeam echo sounder but in shallow water region mostly single beam is used due to its effectiveness. One of the main purposes of longitudinal survey is to calculate out the least available depth. One of the main principles of the detail hydrographic survey is to examine the area of shoal in between the deep pool, i.e. from the deep water at the right hand side and the deep water at the left hand side. The comparison of pre and post dredging charts convey the amount of material dredged.

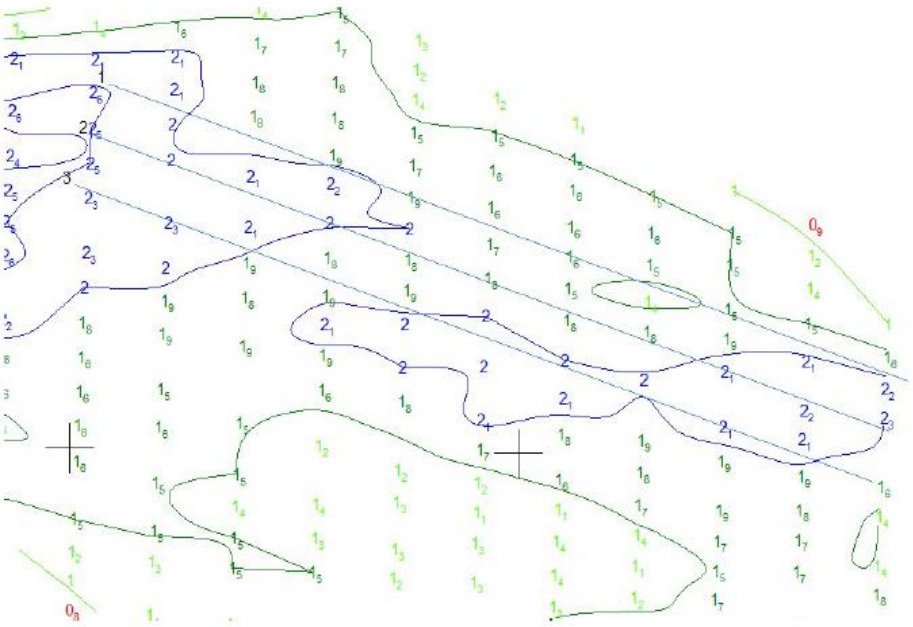
Methodology:

For estimation of the dredge area and volume, the trapezoidal section of the channel is considered whose bottom width is 40m and slope is 1:4..Thus the top width will be 62 cm. The depth to be maintained is 2.5m .A side tolerance of 2m

And bottom tolerance of 0.5m is made, which makes the top width of the channel to beequal to 64m with depth of 3.0m.For calculation of the depth of cut, first the channel is equally divided from center line i.e. 32 divisions on either side. The dredge cross section is obtained by values obtained from graph. Once the soundings are measured and taken across each cross section, The depth of cut will be:Depth of Cut= Tolerance – Pre dredging soundings

If the depth of cut comes out to be negative, then its value is taken as zero as there is no need of dredging at that point. Positive value is stored as original.

In the present case:
Bottom width of designed channel = 40m
Desired depth of designed channel=2.5m
Slope=1:4
Tolerance at bottom=0.5
Tolerance in width on either side of channel=2m



Calculations:

Pre Dredging Survey-

The Area from the given chart is calculated by Simpson's Rule

$$A = \frac{4}{3}(h_{first} + h_{last}) + 4(sum\ of\ even\ entities\ of\ h) + 2(sum\ of odd\ entities\ of\ h)$$

$$= \frac{4}{3}(h_1 + h_l) + 4(h_2+h_4+h_6+h_8+h_{10}+h_{12}+h_{14}+h_{16}) + 2(h_1+h_3+h_5+h_7+h_9+h_{11}+h_{13}+h_{15})$$

Similarly, the Volume of the quantity to be dredged is estimated by trapezoidal method:

$$V = h\left(\frac{A_{first} + A_{last}}{2}\right) + (sum\ of\ remaining\ areas)$$

$$= h\left(\frac{A_{first}+A_{last}}{2}\right) + (A2 + A3 + A4 + A5 + A6 + A7 + A8 + A9 + A10)$$

Where $h = \frac{Total\ length\ of\ shoal}{Total\ number\ of\ lines-1} = \frac{320}{10} = 3.2$

LINE 1

Sounding position from Center	Pre Dredging Sounding(as per chart)	Design Cross-Section	Cross section with permissible tolerance	Depth of Cut	sequence	Final Depth of cut
32	1.6	0	0	-1.6	h1	0
28	1.7	0.5	1.2	-0.5	h2	0
24	1.8	1.5	2.4	0.6	h3	0.6
20	1.9	2.5	3	1.1	h4	1.1
16	2	2.5	3	1	h5	1
12	2.1	2.5	3	0.9	h6	0.9
8	2.2	2.5	3	0.8	h7	0.8
4	2.2	2.5	3	0.8	h8	0.8
0	2.3	2.5	3	0.7	h9	0.7
4	2.2	2.5	3	0.8	h10	0.8
8	2.1	2.5	3	0.9	h11	0.9
12	2	2.5	3	1	h12	1
16	1.9	2.5	3	1.1	h13	1.1
20	1.9	2.5	3	1.1	h14	1.1
24	1.8	1.5	2.4	0.6	h15	0.6
28	1.7	0.5	1.2	-0.5	h16	0
32	1.6	0	0	-1.6	h17	0
AREA A1	34.2	sqm				

LINE 2

Sounding position from Center	Pre Dredging Sounding(as per chart)	Design Cross-Section	Cross section with permissible tolerance	Depth of Cut	sequence	Final Depth of cut
32	1.6	0	0	-1.6	h1	0
28	1.7	0.5	1.2	-0.5	h2	0
24	1.8	1.5	2.4	0.6	h3	0.6
20	1.9	2.5	3	1.1	h4	1.1
16	2	2.5	3	1	h5	1
12	2.1	2.5	3	0.9	h6	0.9
8	2.2	2.5	3	0.8	h7	0.8
4	2.2	2.5	3	0.8	h8	0.8
0	2.3	2.5	3	0.7	h9	0.7
4	2.2	2.5	3	0.8	h10	0.8
8	2.1	2.5	3	0.9	h11	0.9
12	2	2.5	3	1	h12	1
16	1.9	2.5	3	1.1	h13	1.1
20	1.8	2.5	3	1.2	h14	1.2
24	1.8	1.5	2.4	0.6	h15	0.6
28	1.9	0.5	1.2	-0.7	h16	0
32	2	0	0	-2	h17	0
AREA A2	34.6	sqm				

LINE 3

Sounding position from Center	Pre Dredging Sounding(as per chart)	Design Cross-Section	Cross section with permissible tolerance	Depth of Cut	sequence	Final Depth of cut
32	1.5	0	0	-1.5	h1	0
28	1.6	0.5	1.2	-0.4	h2	0
24	1.7	1.5	2.4	0.7	h3	0.7
20	1.8	2.5	3	1.2	h4	1.2
16	1.8	2.5	3	1.2	h5	1.2
12	1.8	2.5	3	1.2	h6	1.2
8	1.9	2.5	3	1.1	h7	1.1
4	2	2.5	3	1	h8	1
0	2.1	2.5	3	0.9	h9	0.9
4	1.9	2.5	3	1.1	h10	1.1
8	1.8	2.5	3	1.2	h11	1.2
12	1.9	2.5	3	1.1	h12	1.1
16	1.9	2.5	3	1.1	h13	1.1
20	2	2.5	3	1	h14	1
24	2.1	1.5	2.4	0.3	h15	0.3
28	2.1	0.5	1.2	-0.9	h16	0
32	2.1	0	0	-2.1	h17	0
AREA A3	39.4	sqm				

LINE 4

Sounding position from Center	Pre Dredging Sounding(as per chart)	Design Cross-Section	Cross section with permissible tolerance	Depth of Cut	sequence	Final Depth of cut
32	1.4	0	0	-1.4	h1	0
28	1.4	0.5	1.2	-0.2	h2	0
24	1.4	1.5	2.4	1	h3	1
20	1.5	2.5	3	1.5	h4	1.5
16	1.5	2.5	3	1.5	h5	1.5
12	1.5	2.5	3	1.5	h6	1.5
8	1.6	2.5	3	1.4	h7	1.4
4	1.7	2.5	3	1.3	h8	1.3
0	1.8	2.5	3	1.2	h9	1.2
4	1.9	2.5	3	1.1	h10	1.1
8	1.9	2.5	3	1.1	h11	1.1
12	1.9	2.5	3	1.1	h12	1.1
16	2	2.5	3	1	h13	1
20	2	2.5	3	1	h14	1
24	2.1	1.5	2.4	0.3	h15	0.3
28	2.1	0.5	1.2	-0.9	h16	0
32	2.1	0	0	-2.1	h17	0
AREA A4	45	sqm				

Similarly,
Area for Line 5=42 m^2
Area for Line 6=42.4 m^2 Area for Line 7=44.6 m^2
Area for Line 8=44.8m^2 Area for Line 9=34.4 m^2
Area for Line 10=33.2 m^2
Area for Line 11=20 m^2
Estimated volume to be dredged =12400 m^3

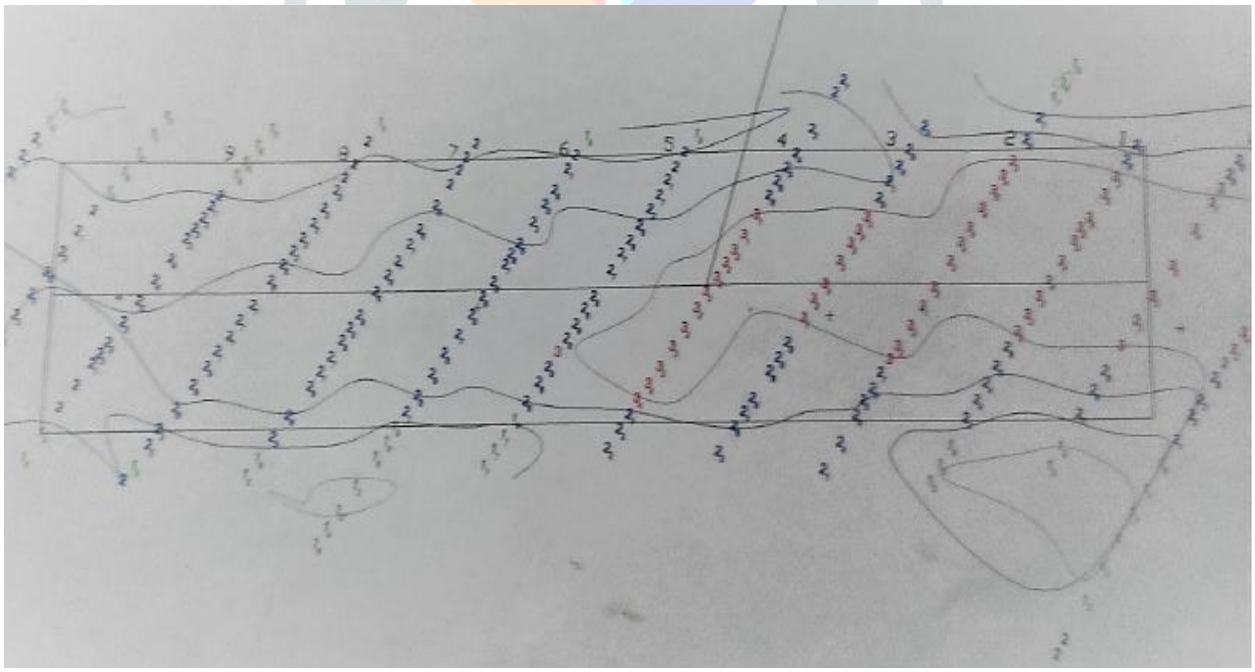
Post Dredging Survey:

The insitu calculation involves the length(spud movement)covered by dredger in oneday , the depth of cut(desired depth-present depth) and swing length(taken as 34 m practically) .The swing is hypothetically 20m on either side making it 40 m but after considering slope of soil,34 meters is initially taken.

Date	Number of spuds	Total Length	Depth of Cut	Swing length	Quantity Dredged (cubm)	
19/02/17	14	42	1.5	35	2205	
20/02/17	15	45	1.3	35	2047.5	
21/02/17	15	45	1.5	35	2362.5	
22/02/17	4	12	1.5	35	630	
23/02/17	20	60	1.7	35	3570	
24/02/17	14	42	1.6	35	2352	
25/02/17	22	66	1.5	35	3465	
26/02/17	8	24	1.5	35	1260	
	Total length dredged	336		Total Quantity Dredged	17892	Cubic meters

The total Quantity Dredged is 17892cubic meters

Once the operation has started, and a considerable amount of soil is dredged, a series of detailed hydrographic surveys are done after regular intervals while dredger is in operation. Final Post dredging hydrographic survey chart is also enclosed for the same site to check whether the decided depth is obtained or not and also to quantify the dredging. The post dredging chart is shown below.



The method of calculation of area and volume from the post dredging soundings are made similar to that a pre dredging survey, the only difference is that, the water level correction is taken into consideration. It is seen that water level may vary from start of the operation to end of the operation. Thus, a correction factor of 0.6 is added to thepost dredging soundings and calculation of the quantity is made. It has to be noted that if post dredging soundings after making water level correction is greater than the tolerance, then

Depth of cut = Tolerance – Pre dredging soundings

And If dredging soundings after taking water level corrections is lesser than tolerance, then

Depth of cut = Post dredging sounding- Pre dredging soundings

LINE 1

Sounding position from Center	Pre Dredging Sounding (as per chart)	Post Dredging Sounding	Post sounding after applying correction	Design Cross-Section	Cross section with permissible tolerance	Depth of Cut	sequence	Final Depth of cut
32	3	3	3.6	0	0	-3	h1	0
28	2.9	2.9	3.5	0.5	1.2	-1.7	h2	0
24	3	2.8	3.4	1.5	2.4	-0.6	h3	0
20	3	2.9	3.5	2.5	3	0	h4	0
16	2.8	3	3.6	2.5	3	0.2	h5	0.2
12	2.7	3.1	3.7	2.5	3	0.3	h6	0.3
8	2.6	3.4	4	2.5	3	0.4	h7	0.4
4	2.7	3.5	4.1	2.5	3	0.3	h8	0.3
0	2.8	3.5	4.1	2.5	3	0.2	h9	0.2
4	2.7	3.3	3.9	2.5	3	0.3	h10	0.3
8	2.5	3	3.6	2.5	3	0.5	h11	0.5
12	2.3	2.8	3.4	2.5	3	0.7	h12	0.7
16	2.1	2.6	3.2	2.5	3	0.9	h13	0.9
20	1.8	2.2	2.8	2.5	3	1	h14	1
24	1.6	2.3	2.9	1.5	2.4	0.8	h15	0.8
28	1.4	2.3	2.9	0.5	1.2	-0.2	h16	0
32	1.3	2.4	3	0	0	-1.3	h17	0
A1		16.4	sqm					

LINE 2

Sounding position from Center	Pre Dredging Sounding (as per chart)	Post Dredging Sounding	Post sounding after applying correction	Design Cross-Section	Cross section with permissible tolerance	Depth of Cut	sequence	Final Depth of cut
32	3.2	2.8	3.4	0	0	-3.2	h1	0
28	3.2	3.2	3.8	0.5	1.2	-2	h2	0
24	3.1	3.5	4.1	1.5	2.4	-0.7	h3	0
20	3.1	3.6	4.2	2.5	3	-0.1	h4	0
16	3.1	3.5	4.1	2.5	3	-0.1	h5	0
12	2.8	3.5	4.1	2.5	3	0.2	h6	0.2
8	2.5	3.4	4	2.5	3	0.5	h7	0.5
4	2.3	3.4	4	2.5	3	0.7	h8	0.7
0	2	3.4	4	2.5	3	1	h9	1
4	1.8	3.3	3.9	2.5	3	1.2	h10	1.2
8	1.8	3.3	3.9	2.5	3	1.2	h11	1.2
12	1.7	3.2	3.8	2.5	3	1.3	h12	1.3
16	1.7	2.8	3.4	2.5	3	1.3	h13	1.3
20	1.7	2.5	3.1	2.5	3	1.3	h14	1.3
24	1.7	2.4	3	1.5	2.4	0.7	h15	0.7
28	1.6	2.4	3	0.5	1.2	-0.4	h16	0
32	1.3	2.2	2.8	0	0	-1.3	h17	0
A2		28.2	sqm					

Similarly

Area Dredged for Line 3=40 m^2

Area Dredged for Line 4=42 m^2

Area Dredged for Line 5= 41 m^2

Area Dredged for Line 6=44.6 m^2

Area Dredged for Line 7= 40 m^2

Area Dredged for Line 8=34.8 m^2

Area Dredged for Line 9=33.6

Area Dredged for Line 10=17.6 m^2

Area Dredged for Line 11= 15 m^2

Total Volume Dredged is 10806m^3

Conclusions:

1. The comparison of pre and post dredging survey charts and calculation of volume shows that the volume dredged is thinly greater than the estimated volume which shows the efficient economic working on field.
2. The volumes are almost equal after dredging operation
3. The dredged volume makes the channel perfect for navigation

References:

1. The Hydrographic Charts of Inland Waterways Authority of India, Patna
2. The physical significance of Hydrographic Survey-A Detailed Approach by P Raj Palani, New Delhi
3. Theory of Dredgers by GG Rao, Andhra Pradesh