

# Ship Stability

September 2013

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# Term Project

# Overview (1/3)

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## ☑ Objective

- To develop a program for generating hydrostatic tables and plotting hydrostatic curves after calculating hydrostatic values for the given offsets table

## ☑ Given

- Ship: 6,300TEU Container Ship
- Principal dimensions and other information
  - LOA 278.05m, LBP 264.05m, B 40.0m, D 24.2m, Td 12.0m, Ts 14.5m
  - Keel Plate Thickness: 0.025m
  - Density of sea water: 1.025ton/m<sup>3</sup>
- Offsets table

## ☑ Requirements

- Hydrostatic values to be calculated
  - Volume<sub>mld</sub>, Volume<sub>ext</sub>, Displacement<sub>mld</sub>, Displacement<sub>ext</sub>, LCB, LCF, VCB, KB<sub>T</sub>, BM<sub>T</sub>, KM<sub>T</sub>, KB<sub>L</sub>, BM<sub>L</sub>, KM<sub>L</sub>, MTC, TPC, WSA, CB, CWP, CM, CP
- Drafts to be calculated
  - all drafts of offsets table
  - If you need, use the linear interpolation between the given data.

# Overview (2/3)

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## ☑ Output

- Hydrostatic tables
- Hydrostatic curves

## ☑ Implementation

- Any program language (C++ [Recommended], BASIC, FORTRAN) or tool (Matlab, MS Excel) can be used.
- However, the grading is different according to the language or tool what you select.
- Evaluate the validity of your program by comparing the results with that of lecture notes and discuss its results in your report.
- **Do not copy! If it is found out, you will get 'F'. Do it yourself!**

## ☑ Due date: 23:59 on 17<sup>th</sup> December, 2013

# Overview (3/3)

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## ☑ Submissions

- Report for the term project (MS word file)
- Source files including an executable file.
- After compressing all files in one file (e.g., YourStudentNumber.zip) and upload to our eTL homepage.

# Offsets Table of a 6,300TEU Container Ship (1/2)

→ Waterline

\* Unit: mm

↓ Stations

Station NO.	HALF BREADTH FROM CENTER LINE																			Station NO.		
	BOTT OM LINE	1 W.L	2 W.L	3 W.L	4 W.L	5 W.L	6 W.L	7 W.L	8 W.L	9 W.L	10 W.L	11 W.L	12 W.L	13 W.L	14.5 W.L	16 W.L	18 W.L	20 W.L	22 W.L		24.2 W.L	
Trans. (-0.38)	Half-Breadth																			Trans. (-0.38)		
-0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10525	15955	18890	19944	20000	*	-0.19
AP	-	-	-	-	-	-	-	-	-	-	-	-	-	2627	12572	16765	19204	19994	20000	*	AP	
0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	8474	14763	17871	19596	20000	*	*	0.25	
0.5	-	-	-	-	-	-	-	-	-	-	-	-	3283	11746	16178	18456	19824	20000	*	*	0.5	
0.75	-	-	-	487	933	530	-	-	-	-	0	1846	8680	13817	17230	18948	19956	20000	*	*	0.75	
1	-	93	1802	1870	1462	863	397	183	280	895	2275	5061	12168	15561	18071	19440	20000	*	*	*	1	
1.5	49	1879	2372	2520	2446	2215	2059	2283	2919	4288	9026	13623	16033	17687	19196	19906	20000	*	*	*	1.5	
2	534	2677	3363	3734	3932	4029	4250	5085	7289	10680	13943	16341	17896	18937	19811	20000	*	*	*	*	2	
3	2025	5058	6294	7228	8182	9483	11583	14000	16000	17469	18517	19244	19735	19990	20000	*	*	*	*	*	3	
4	3974	8451	10473	12071	13627	15218	16635	17938	18937	19594	19941	20000	20000	20000	*	*	*	*	*	*	4	
5	6091	12054	14349	16032	17344	18359	19152	19729	19996	20000	20000	*	*	*	*	*	*	*	*	*	5	
6	8152	14697	16708	18069	19011	19627	19952	20000	20000	*	*	*	*	*	*	*	*	*	*	*	*	6
7	10187	16515	18101	19113	19728	19985	20000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	7
8	12286	17500	18738	19502	19915	20000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8
9	13900	17562	18720	19408	19815	20000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	9
10	13517	17469	18718	19466	19926	20000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	10
11	12406	16799	18306	19265	19873	20000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	11
12	11001	15632	17338	18464	19316	19887	20000	20000	*	*	*	*	*	*	*	*	*	*	*	*	*	12
13	9018	14029	15875	17152	18138	18941	19528	19922	20000	20000	20000	20000	*	*	*	*	*	*	*	*	13	
14	6196	11304	13404	14934	16146	17141	17974	18650	19199	19622	19886	19994	20000	20000	20000	*	*	*	*	*	14	
15	2993	7980	10216	11870	13217	14356	15353	16246	17038	17740	18354	18882	19312	19633	19929	20000	20000	*	*	*	15	
16	583	5356	7103	8420	9598	10677	11684	12651	13581	14471	15328	16159	16935	17624	18572	19322	19877	20000	20000	*	16	
17	124	3602	4805	5656	6434	7181	7919	8674	9438	10248	11052	11859	12734	13663	15032	16321	17837	19014	19797	20000	17	
18	100	2577	3442	3967	4341	4643	4932	5224	5554	5931	6346	6845	7479	8235	9516	10921	13033	15277	17449	19250	18	
18.5	110	2286	2979	3414	3673	3815	3893	3951	4012	4115	4320	4603	4959	5458	6511	7872	10049	12543	15057	17488	18.5	
19	112	1982	2596	2988	3195	3258	3215	3104	2954	2804	2723	2710	2780	3087	3833	4987	7036	9433	11867	14527	19	
19.5	-	1538	2160	2550	2778	2891	2894	2784	2569	2231	1760	1385	1247	1279	1685	2532	4262	6237	8428	10884	19.5	
FP	-	-	1195	1825	2310	2652	2859	2901	2768	2497	2060	1301	-	29	148	603	1551	2981	4700	6815	FP	
20.23	-	-	-	1353	2045	2481	2753	2893	2890	2686	2125	697	-	-	-	-	-	1590	3135	5042	20.23	
20.45	-	-	-	-	-	1300	1910	2258	2420	2400	2110	1320	-	-	-	-	-	-	-	2343	20.45	
20.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.68	

# Offsets Table of a 6,300TEU Container Ship (2/2)

OFF-SETS TABLE																					
STA. NO.	HALF BREADTH FROM CENTER LINE																				STA. NO
	BOTTOM LINE	1.00 W.L	2.00 W.L	3.00 W.L	4.00 W.L	5.00 W.L	6.00 W.L	7.00 W.L	8.00 W.L	9.00 W.L	10.00 W.L	11.00 W.L	12.00 W.L	13.00 W.L	14.50 W.L	16.00 W.L	18.00 W.L	20.00 W.L	22.00 W.L	24.20 W.L	
Trans. (-0.38)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14450	18262	19780	20000	20000	Trans. (-0.38)
-0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10525	15955	18890	19944	20000	20000	-0.19
A.P	-	-	-	-	-	-	-	-	-	-	-	-	-	2627	12572	16765	19204	19994	20000	20000	A.P
0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	8474	14763	17871	19596	20000	20000	20000	0.25
0.50	-	-	-	-	-	-	-	-	-	-	-	-	3283	11746	16178	18456	19824	20000	20000	20000	0.50
0.75	-	-	-	487	933	530	-	-	-	-	0	1846	8680	13817	17230	18948	19956	20000	20000	20000	0.75
1.00	-	93	1802	1870	1462	863	397	183	280	895	2275	5061	12168	15561	18071	19440	20000	20000	20000	20000	1.00
1.50	49	1879	2372	2520	2446	2215	2059	2283	2919	4288	9026	13623	16033	17687	19196	19906	20000	20000	20000	20000	1.50
2.00	534	2677	3363	3734	3932	4029	4250	5085	7289	10680	13943	16341	17896	18937	19811	20000	20000	20000	20000	20000	2.00
3.00	2025	5058	6294	7228	8182	9483	11583	14000	16000	17469	18517	19244	19735	19990	20000	20000	20000	20000	20000	20000	3.00
4.00	3974	8451	10473	12071	13627	15218	16635	17938	18937	19594	19941	20000	20000	20000	20000	20000	20000	20000	20000	20000	4.00
5.00	6091	12054	14349	16032	17344	18359	19152	19729	19996	20005	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	5.00
6.00	8152	14697	16708	18069	19011	19627	19952	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	6.00
7.00	10187	16515	18101	19113	19728	19985	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	7.00
8.00	12286	17500	18738	19502	19915	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	8.00
9.00	13900	17562	18720	19408	19815	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9.00
10.00	13517	17469	18718	19466	19926	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	10.00
11.00	12406	16799	18306	19265	19873	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11.00
12.00	11001	15632	17338	18464	19316	19887	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	12.00
13.00	9018	14029	15875	17152	18138	18941	19528	19922	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13.00
14.00	6196	11304	13404	14934	16146	17141	17974	18650	19199	19622	19886	19994	20000	20000	20000	20000	20000	20000	20000	20000	14.00
15.00	2993	7980	10216	11870	13217	14356	15353	16246	17038	17740	18354	18882	19312	19633	19929	20000	20000	20000	20000	20000	15.00
16.00	583	5356	7103	8420	9598	10677	11684	12651	13581	14471	15328	16159	16935	17624	18572	19322	19877	20000	20000	20000	16.00
17.00	124	3602	4805	5656	6434	7181	7919	8674	9438	10248	11052	11859	12734	13663	15032	16321	17837	19014	19797	20000	17.00
18.00	100	2577	3442	3967	4341	4643	4932	5224	5554	5931	6346	6845	7479	8235	9516	10921	13033	15277	17449	19250	18.00
18.50	110	2286	2979	3414	3673	3815	3893	3951	4012	4115	4320	4603	4959	5458	6511	7872	10049	12543	15057	17488	18.50
19.00	112	1982	2596	2988	3195	3258	3215	3104	2954	2804	2723	2710	2780	3087	3833	4987	7036	9433	11867	14527	19.00
19.50	-	1538	2160	2550	2778	2891	2894	2784	2569	2231	1760	1385	1247	1279	1685	2532	4262	6237	8428	10884	19.50
F.P	-	-	1195	1825	2310	2652	2859	2901	2768	2497	2060	1301	-	29	148	603	1551	2981	4700	6815	F.P
20.23	-	-	-	1353	2045	2481	2753	2893	2890	2686	2125	697	-	-	-	-	-	1590	3135	5042	20.23
20.45	-	-	-	-	-	1300	1910	2258	2420	2400	2110	1320	-	-	-	-	-	-	-	2343	20.45
20.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.68

# [References] Example of Hydrostatic Tables of a 6,300TEU Container Ship (1/2)

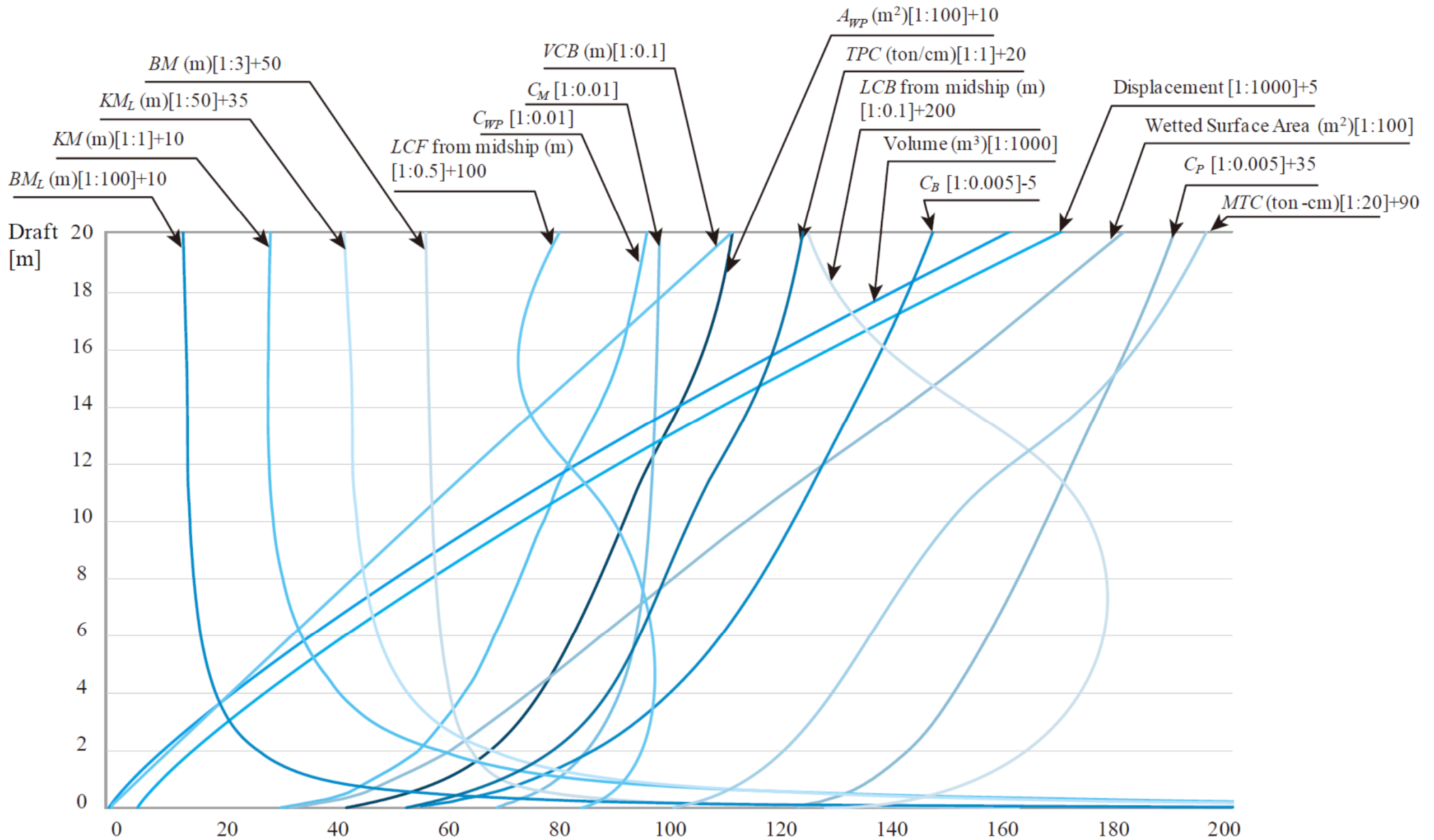
DRAFT (M)	DISP MLD(M <sup>3</sup> )	DISP EXT(Ton)	VCB (M)	LCB (M)	LCF (M)	KM (M)	KM <sub>L</sub> (M)	MTC (T-M)	TPC (Ton)	WSA (M <sup>2</sup> )	C <sub>B</sub>	C <sub>w</sub>	C <sub>P</sub>	C <sub>M</sub>
4.000	22054.0	22720.3	2.171	-2.732	-1.546	31.537	926.651	795.5	68.5	7474.0	0.5248	0.6332	0.5769	0.9097
4.050	22389.1	23064.3	2.199	-2.714	-1.535	31.314	916.847	798.9	68.7	7507.8	0.5261	0.6349	0.5777	0.9107
4.100	22726.2	23410.3	2.226	-2.697	-1.523	31.098	907.266	802.4	68.9	7541.5	0.5275	0.6367	0.5786	0.9118
4.150	23053.3	23756.4	2.253	-2.680	-1.511	30.889	897.964	805.9	69.1	7575.3	0.5288	0.6384	0.5794	0.9128
4.200	23400.4	24102.4	2.281	-2.663	-1.500	30.686	888.93	809.3	69.3	7609.1	0.5302	0.6402	0.5802	0.9138
4.250	23737.5	24448.5	2.308	-2.646	-1.488	30.490	880.152	812.8	69.5	7642.9	0.5314	0.6420	0.5810	0.9147
4.300	24077.3	24797.2	2.336	-2.630	-1.476	30.300	871.537	816.3	69.7	7676.7	0.5327	0.6437	0.5818	0.9157
4.350	24419.0	25148.0	2.363	-2.614	-1.465	30.115	863.102	819.8	69.9	7710.5	0.5341	0.6454	0.5826	0.9166
4.400	24760.7	25498.8	2.391	-2.598	-1.453	29.936	854.9	823.3	70.1	7744.3	0.5354	0.6472	0.5835	0.9176
4.450	25102.4	25849.6	2.418	-2.582	-1.441	29.762	846.921	826.7	70.3	7778.1	0.5366	0.6489	0.5843	0.9185
...														
7.500	47233.9	48564.4	4.087	-2.084	-2.217	21.918	560.803	1023.9	78.2	9736.7	0.5979	0.7224	0.6283	0.9517
7.550	47615.8	48956.4	4.115	-2.086	-2.257	21.852	558.143	1027.2	78.3	9768.7	0.5988	0.7235	0.6290	0.9520
7.600	47999.0	49349.6	4.142	-2.088	-2.302	21.785	555.428	1030.3	78.4	9800.7	0.5996	0.7246	0.6296	0.9523
7.650	48382.1	49742.8	4.170	-2.090	-2.348	21.722	552.756	1033.4	78.6	9832.7	0.6004	0.7256	0.6303	0.9527
7.700	48765.2	50136.0	4.197	-2.092	-2.393	21.659	550.126	1036.6	78.7	9864.6	0.6013	0.7267	0.6309	0.9530
7.750	49148.4	50529.3	4.224	-2.094	-2.438	21.598	547.537	1039.7	78.8	9896.6	0.6021	0.7277	0.6316	0.9533
7.800	49533.1	50924.1	4.252	-2.097	-2.483	21.538	544.992	1042.9	78.9	9928.6	0.6029	0.7288	0.6322	0.9536
7.850	49919.1	51320.2	4.279	-2.100	-2.527	21.481	542.488	1046.1	79.0	9960.7	0.6037	0.7298	0.6329	0.9539
7.900	50305.0	51716.3	4.307	-2.104	-2.571	21.424	540.023	1049.2	79.1	9992.8	0.6045	0.7309	0.6335	0.9542
7.950	50690.9	52112.3	4.334	-2.107	-2.615	21.369	537.595	1052.4	79.2	10024.8	0.6053	0.7319	0.6342	0.9544
...														



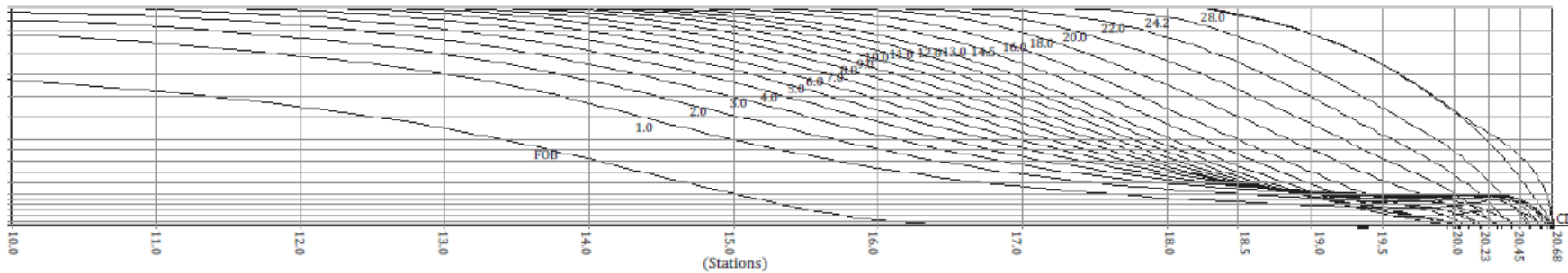
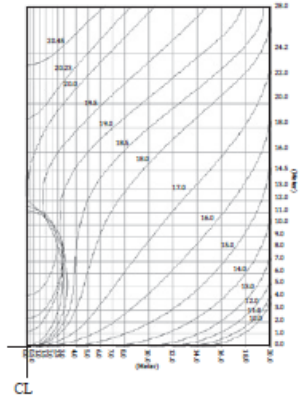
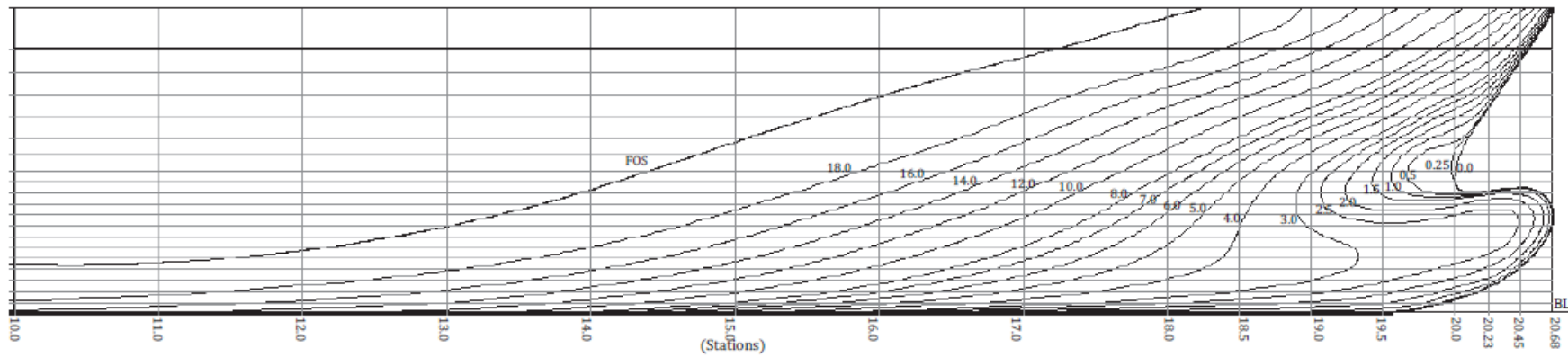
# [References] Example of Hydrostatic Tables of a 6,300TEU Container Ship (2/2)

DRAFT (M)	DISP MLD(M <sup>3</sup> )	DISP EXT(Ton)	VCB (M)	LCB (M)	LCF (M)	KM (M)	KM <sub>L</sub> (M)	MTC (T-M)	TPC (Ton)	WSA (M <sup>2</sup> )	C <sub>B</sub>	C <sub>W</sub>	C <sub>P</sub>	C <sub>M</sub>
11.750	81677.2	83912.8	6.431	-3.298	-8.607	18.919	430.346	1347.2	88.1	12595.4	0.6593	0.8134	0.6803	0.9692
11.800	82107.4	84354.3	6.459	-3.326	-8.710	18.912	430.028	1353.1	88.2	12631.3	0.6600	0.8148	0.6809	0.9693
11.850	82539.1	84797.3	6.487	-3.355	-8.816	18.905	429.787	1359.4	88.4	12667.6	0.6606	0.8162	0.6815	0.9695
11.900	82970.8	85240.4	6.515	-3.384	-8.923	18.900	429.549	1365.5	88.5	12703.9	0.6613	0.8176	0.6820	0.9696
11.950	83402.4	85683.4	6.543	-3.413	-9.030	18.894	429.313	1371.9	88.7	12740.2	0.6620	0.8190	0.6826	0.9697
12.000	83634.1	86126.4	6.571	-3.442	-9.136	18.889	429.081	1378.1	88.8	12776.5	0.6626	0.8204	0.6832	0.9698
12.050	84267.9	86571.6	6.599	-3.471	-9.233	18.879	428.885	1384.5	89.0	12812.5	0.6633	0.8218	0.6838	0.9700
12.100	84703.3	87018.4	6.627	-3.501	-9.323	18.866	428.717	1391.0	89.1	12848.3	0.6639	0.8231	0.6844	0.9701
12.150	85138.6	87465.1	6.655	-3.531	-9.413	18.853	428.551	1397.5	89.3	12884.0	0.6646	0.8245	0.6850	0.9702
12.200	85573.9	87911.9	6.683	-3.561	-9.503	18.840	428.387	1404.0	89.4	12919.8	0.6652	0.8258	0.6856	0.9703
12.250	86009.2	88358.7	6.711	-3.591	-9.593	18.826	428.224	1410.5	89.5	12955.6	0.6659	0.8271	0.6862	0.9705
...														
14.250	104062.4	106885.2	7.843	-4.937	-12.788	18.585	423.63	1683.1	95.4	14391.6	0.6924	0.8808	0.7105	0.9746
14.300	104528.0	107363.1	7.872	-4.973	-12.837	18.604	423.328	1689.2	95.5	14426.2	0.6931	0.8819	0.7111	0.9747
14.350	104995.0	107842.2	7.901	-5.008	-12.880	18.683	423.056	1695.6	95.6	14461.0	0.6938	0.8831	0.7117	0.9748
14.400	105451.9	108321.3	7.929	-5.042	-12.940	18.683	422.786	1701.9	95.7	14495.8	0.6944	0.8843	0.7123	0.9749
14.450	105928.8	108800.4	7.958	-5.077	-12.992	18.682	422.519	1708.2	95.9	14530.6	0.6951	0.8854	0.7129	0.9750
14.500	106395.7	109279.6	7.986	-5.112	-13.043	18.682	422.255	1714.5	96.0	14565.4	0.6957	0.8866	0.7135	0.9751
14.550	106864.4	109760.5	8.015	-5.147	-13.090	18.682	422.01	1720.9	96.1	14600.3	0.6964	0.8878	0.7141	0.9751
14.600	107334.5	110242.8	8.043	-5.182	-13.133	18.681	421.779	1727.4	96.2	14635.1	0.6971	0.8889	0.7148	0.9752
14.650	107804.5	110725.1	8.072	-5.217	-13.176	18.681	421.55	1733.9	96.4	14970.0	0.6977	0.8901	0.7154	0.9753
14.700	108274.5	111207.4	8.101	-5.251	-13.219	18.681	421.323	1740.3	96.5	14704.9	0.6984	0.8912	0.7160	0.9754

# [References] Example of Hydrostatic Curves of a 6,300TEU Container Ship

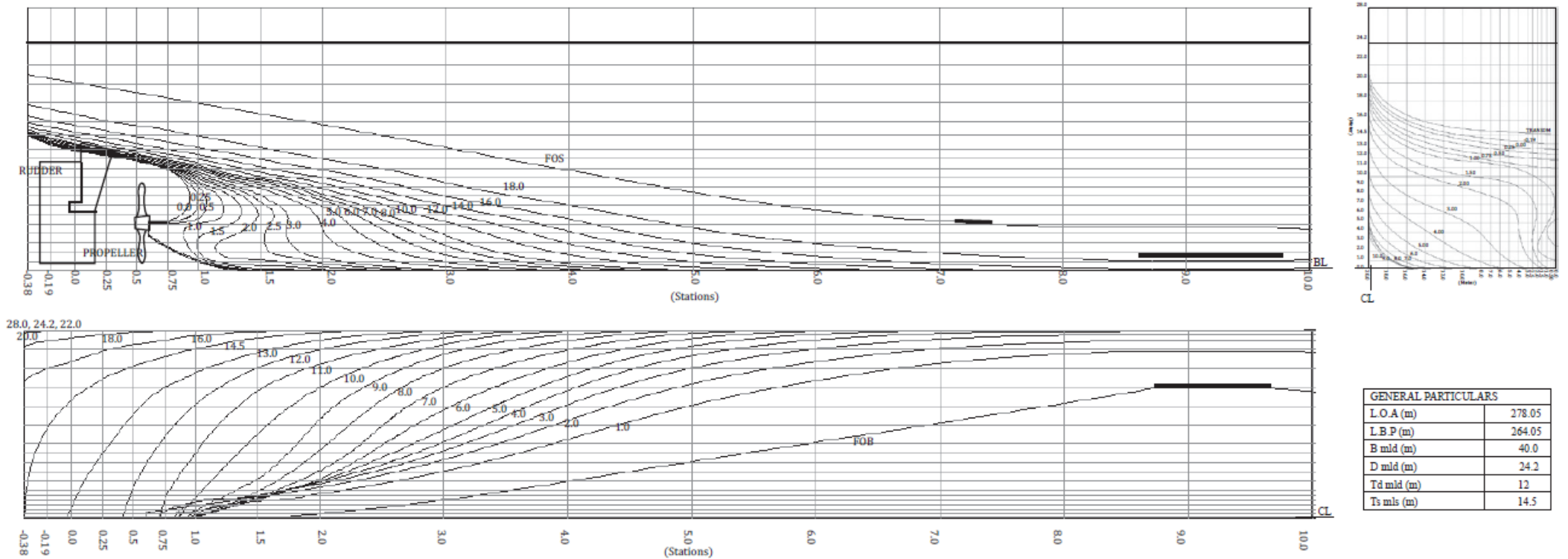


# [Reference] Lines of a 6,300TEU Container Ship - Fore Body



GENERAL PARTICULARS	
L.O.A (m)	278.05
L.B.P (m)	264.05
B mld (m)	40.0
D mld (m)	24.2
Td mld (m)	12
Ts mis (m)	14.5

# [Reference] Lines of a 6,300TEU Container Ship - After Body



# Guide for Term Project

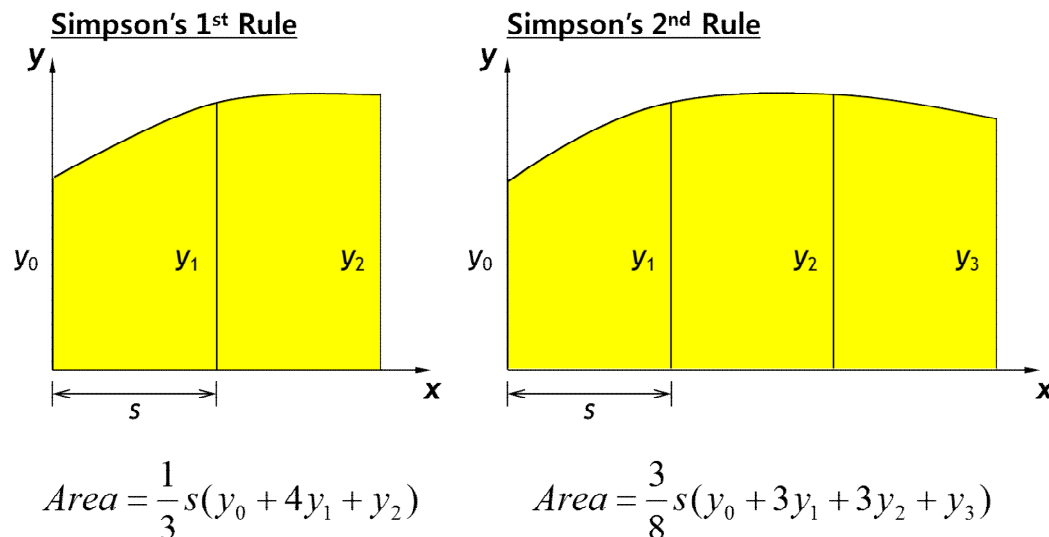
# Overall Procedures

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- ☑ Step 1: Modification of offsets table to apply Simpson's rules
- ☑ Step 2: Determination of the integral method for stations and water lines
- ☑ Step 3: Assumption of the draft
- ☑ Step 4: Calculation of the sectional area for each station and the water plane area for each water line
- ☑ Step 5: Calculation of the displacement volume and the 1<sup>st</sup> moment of the displacement volume from the sectional area for each station ("longitudinal integration") or from the water plane area for each water line ("vertical integration")
- ☑ Step 6: Calculation of other items of hydrostatic values.
- ☑ Step 7: Go to Step 3 and repeat above.

# Step 1: Modification of Offsets Table

- ☑ Simpson's rules can be applied for half-breadths or areas having the same spacing for station and water line.
  - For Simpson's 1<sup>st</sup> rule, three ordinates are required.
  - For Simpson's 2<sup>nd</sup> rule, four ordinates are required.
  
- ☑ If needed, an offsets table should be modified.
  - For example, if we have half-breadths for the station 0.0, 0.25, 0.5, and 1.0, half-breadths for the station 0.75 should be given. To do this, we can generate that from the linear interpolation between that of the station 0.5 and 1.0.



Before:

St. 0.0 0.25 0.5 1.0

➔ How can we apply Simpson's rule?

After:

St. 0.0 0.25 0.5 0.75 1.0

➔ Now, we can apply Simpson's 1<sup>st</sup> rule for the station (0.0, 0.25, 0.5) and the station (0.5, 0.75, 1.0).



# Step 2: Determination of the Integral Method (1/2)

## - Stations

OFF-SETS TABLE																					
STA. NO.	HALF BREADTH FROM CENTER LINE																				STA. NO.
	BOTTOM LINE	1.00 W.L.	2.00 W.L.	3.00 W.L.	4.00 W.L.	5.00 W.L.	6.00 W.L.	7.00 W.L.	8.00 W.L.	9.00 W.L.	10.00 W.L.	11.00 W.L.	12.00 W.L.	13.00 W.L.	14.50 W.L.	16.00 W.L.	18.00 W.L.	20.00 W.L.	22.00 W.L.	24.20 W.L.	
Trans. (-0.38)																14450	18262	19780	20000	20000	Trans. (-0.38)
-0.19															10525	15955	18890	19944	20000	20000	-0.19
A.P.														2627	12572	16765	19204	19994	20000	20000	A.P.
0.25														8474	14763	17871	19596	20000	20000	20000	0.25
0.50													3283	11746	16178	18456	19824	20000	20000	20000	0.50
0.75				487	933	530					0	1846	8680	13817	17230	18948	19956	20000	20000	20000	0.75
1.00		93		1807	1462	863	397	183	280	895	2275	5061	12168	15561	18071	19440	20000	20000	20000	20000	1.00
1.50	49	1879		2372	2446	2215	2059	2283	2919	4288	9026	13623	16033	17687	19196	19906	20000	20000	20000	20000	1.50
2.00	534	2677		3363	3932	4029	4250	5085	7289	10680	13943	16341	17896	18937	19811	20000	20000	20000	20000	20000	2.00
3.00	2025	5058		6294	8182	9483	11583	14000	16000	17469	18517	19244	19735	19990	20000	20000	20000	20000	20000	20000	3.00
4.00	3974	8451		10473	12071	13627	15218	16635	17938	18937	19594	19941	20000	20000	20000	20000	20000	20000	20000	20000	4.00
5.00	6091	12054		14349	16032	17344	18359	19152	19729	19996	20005	20000	20000	20000	20000	20000	20000	20000	20000	20000	5.00
6.00	8152	14697		16708	18659	19011	19627	19952	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	6.00
7.00	10187	16515		18101	19113	19728	19985	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	7.00
8.00	12286	17500		18738	19502	19915	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	8.00
9.00	13900	17562		18720	19408	19815	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9.00
10.00	13517	17469		18718	19466	19926	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	10.00
11.00	12406	16799		18306	19265	19873	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11.00
12.00	11001	15632		17338	18464	19316	19887	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	12.00
13.00	9018	14029		15875	17152	18138	18941	19528	19922	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13.00
14.00	6196	11304		13404	14934	16146	17111	17874	18650	19199	19622	19886	19994	20000	20000	20000	20000	20000	20000	20000	14.00
15.00	2993	7980		10216	11870	13217	14316	15353	16246	17038	17740	18354	18882	19312	19633	19929	20000	20000	20000	20000	15.00
16.00	583	5356		7103	8420	9598	10617	11684	12651	13581	14471	15328	16159	16935	17624	18572	19322	19877	20000	20000	16.00
17.00	124	3602		4805	5656	6434	7181	7919	8674	9438	10248	11052	11859	12734	13663	15032	16321	17837	19014	19797	17.00
18.00	100	2577		3442	3967	4341	4643	4932	5224	5554	5931	6346	6845	7479	8235	9516	10921	13033	15277	17449	18.00
18.50	110	2286		2979	3414	3673	3815	3893	3951	4012	4115	4320	4603	4959	5458	6511	7872	10049	12543	15057	18.50
19.00	112	1982		2596	2988	3195	3258	3215	3104	2954	2804	2723	2710	2780	3087	3833	4987	7036	9433	11867	19.00
19.50	-	1538		2160	2550	2778	2891	2894	2784	2569	2231	1760	1385	1247	1279	1685	2532	4262	6237	8428	19.50
F.P.	-	-		1195	1825	2310	2652	2859	2900	2768	2497	2060	1301	-	29	148	603	1551	2981	4700	F.P.
20.23	-	-		-	1353	2045	2481	2753	2893	2890	2686	2125	697	-	-	-	-	1590	3135	5042	20.23
20.45	-	-		-	-	-	1300	1910	2258	2420	2400	2110	1320	-	-	-	-	-	-	2343	20.45
20.68	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.68

S1: Simpson's 1<sup>st</sup> rule  
 S2: Simpson's 2<sup>nd</sup> rule  
 s: Station spacing(= LBP/20)



# Step 2: Determination of the Integral Method (2/2)

## - Water Lines

OFF-SETS TABLE																					
STA. NO.	HALF BREADTH FROM CENTER LINE																			STA. NO.	
	BOTTOM LINE	1.00 W.L.	2.00 W.L.	3.00 W.L.	4.00 W.L.	5.00 W.L.	6.00 W.L.	7.00 W.L.	8.00 W.L.	9.00 W.L.	10.00 W.L.	11.00 W.L.	12.00 W.L.	13.00 W.L.	14.50 W.L.	16.00 W.L.	18.00 W.L.	20.00 W.L.	22.00 W.L.		24.20 W.L.
Trans. (-0.38)																14450	18262	19780	20000	20000	Trans. (-0.38)
-0.19																10525	15955	18890	19000	20000	-0.19
A.P															2627	12572	16765	19204	19994	20000	A.P
0.25															8474	14763	17871	19596	20000	20000	0.25
0.50															3283	11746	16178	18456	19824	20000	0.50
0.75				487	933	530							0	1846	8680	13817	17230	18948	19956	20000	0.75
1.00		93	1802	1870	1462	863	397	183	280				5061	12168	15561	18071	19440	20000	20000	1.00	
1.50	49	1879	2372	2520	2446	2215	2059	2283	2919	4288	9026	13623	16033	17687	19196	19906	20000	20000	20000	1.50	
2.00	534	2677	3363	3734	3932	4029	4250	5085	7289	10680	13943	18937	19811	20000	20000	20000	20000	20000	20000	2.00	
3.00	2025	5058	6294	7228	8182	9483	11583	14000	16000	17469	18517	19244	19735	20000	20000	20000	20000	20000	20000	3.00	
4.00	3974	8451	10473	12071	13627	15218	16635	17938	18937	19594	19941	20000	20000	20000	20000	20000	20000	20000	20000	4.00	
5.00	6091	12054	14349	16032	17344	18359	19152	19729	19996	20005	20000	20000	20000	20000	20000	20000	20000	20000	20000	5.00	
6.00	8152	14697	16708	18069	19011	19627	19952	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	6.00	
7.00	10187	16515	18101	19113	19728	19985	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	7.00	
8.00	12286	17500	18738	19502	19915	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	8.00	
9.00	13900	17562	18720	19408	19815	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9.00	
10.00	13517	17469	18718	19466	19926	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	10.00	
11.00	12406	16799	18306	19265	19873	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11.00	
12.00	11001	15632	17338	18464	19316	19887	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	12.00	
13.00	9018	14029	15875	17152	18138	18941	19528	19922	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13.00	
14.00	6196	11304	13404	14934	16146	17141	17974	18650	19199	19622	19886	19994	20000	20000	20000	20000	20000	20000	20000	14.00	
15.00	2993	7980	10216	11870	13217	14356	15353	16246	17038	17740	18354	18882	19312	19633	19929	20000	20000	20000	20000	15.00	
16.00	583	5356	7103	8420	9598	10677	11684	12651	13581	14471	15328	16159	16935	17624	18572	19322	19877	20000	20000	16.00	
17.00	124	3602	4805	5656	6434	7181	7919	8674	9438	10248	11052	11859	12734	13663	15032	16321	17837	19014	19797	17.00	
18.00	100	2577	3442	3967	4341	4643	4932	5224	5554	5931	6346	6845	7479	8235	9516	10921	13033	15277	17449	19250	18.00
18.50	110	2286	2979	3414	3673	3815	3893	3951	4012	4115	4320	4603	4959	5458	6511						18.50
19.00	112	1982	2596	2988	3195	3258	3215	3104	2954	2804	2723	2710	2780	3087	3833						19.00
19.50	-	1538	2160	2550	2778	2891	2894	2784	2569	2231	1760	1385	1247	1279	1685						19.50
F.P	-	-	1195	1825	2310	2652	2859	2901	2768	2497	2060	1301	-	29	148						F.P
20.23	-	-	-	1353	2045	2481	2753	2893	2890	2686	2125	697	-	-	-	-	-	1590	3135	5042	20.23
20.45	-	-	-	-	-	1300	1910	2258	2420	2400	2110	1320	-	-	-	-	-	-	-	2343	20.45
20.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.68

**S1: Simpson's 1<sup>st</sup> rule**  
**S2: Simpson's 2<sup>nd</sup> rule**  
**w: Waterline spacing(= 1.0m)**

# Step 3: Assumption of the Draft

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## ☑ Drafts to be calculated

- 0.0, 1.0, 2.0, 3.0, ..., 12.0, 13.0, 14.5, 16.0, 18.0, 20.0, 22.0, 23.1, 24.2

# Step 4: Calculation of the Sectional Area and the Water Plane Area

## - Sectional Area

### ☑ Example

- Draft to be calculated: **5.0 W.L**
- Station to be calculated: **St. 10**
- Half-breads for St. 10 up to 5.0 W.L

STA. NO.	OFF-SETS TABLE																				STA. NO.
	BOTTOM LINE	1.00 W.L	2.00 W.L	3.00 W.L	4.00 W.L	5.00 W.L	6.00 W.L	7.00 W.L	8.00 W.L	9.00 W.L	10.00 W.L	11.00 W.L	12.00 W.L	13.00 W.L	14.50 W.L	16.00 W.L	18.00 W.L	20.00 W.L	22.00 W.L	24.20 W.L	
Trans. (-0.38)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14450	18262	19780	20000	20000	Trans. (-0.38)
-0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10525	15955	18890	19944	20000	20000	-0.19
A.P	-	-	-	-	-	-	-	-	-	-	-	-	-	2627	12572	16765	19204	19994	20000	20000	A.P
0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	8474	14763	17871	19596	20000	20000	20000	0.25
0.50	-	-	-	-	-	-	-	-	-	-	-	-	3283	11746	16178	18456	19824	20000	20000	20000	0.50
0.75	-	-	-	487	933	530	-	-	-	-	0	1846	8680	13817	17230	18948	19956	20000	20000	20000	0.75
1.00	-	93	1802	1870	1462	863	397	183	280	895	2275	5061	12168	15561	18071	19440	20000	20000	20000	1.00	
1.50	49	1879	2372	2520	2446	2215	2059	2283	2919	4288	9026	13623	16033	17687	19196	19906	20000	20000	20000	1.50	
2.00	534	2677	3363	3734	3932	4029	4250	5085	7289	10680	13943	16341	17896	18937	19811	20000	20000	20000	20000	2.00	
3.00	2025	5058	6294	7228	8182	9483	11583	14000	16000	17469	18517	19244	19735	19990	20000	20000	20000	20000	20000	3.00	
4.00	3974	8451	10473	12071	13627	15218	16635	17938	18937	19594	19941	20000	20000	20000	20000	20000	20000	20000	20000	4.00	
5.00	6091	12054	14349	16032	17344	18359	19152	19729	19996	20005	20000	20000	20000	20000	20000	20000	20000	20000	20000	5.00	
6.00	8152	14697	16708	18069	19011	19627	19952	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	6.00	
7.00	10187	16515	18101	19113	19728	19985	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	7.00	
8.00	12286	17500	18738	19502	19915	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	8.00	
9.00	13900	17562	18720	19408	19815	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9.00	
10.00	13517	17469	18718	19466	19926	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	10.00	
11.00	12405	16280	18206	19265	19873	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11.00	
12.00	S2(1.0w)	15667	17338	18464	19316	19887	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	12.00	
13.00	9018	14029	15875	16932	18138	1941	19528	19922	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13.00	
14.00	6196	11304	13404	15111	17141	17974	18650	19199	19622	19886	19994	20000	20000	20000	20000	20000	20000	20000	20000	14.00	
15.00	2993	7980	10216	11870	13217	14356	15353	16246	17038	17740	18354	18882	19312	19633	19929	20000	20000	20000	20000	15.00	
16.00	583	5356	7103	8420	9598	10677	11684	12651	13581	14471	15328	16159	16935	17624	18572	19322	19877	20000	20000	16.00	
17.00	124	3602	4805	5656	6434	7181	7919	8674	9438	10248	11052	11859	12734	13663	15032	16321	17837	19014	19797	17.00	
18.00	100	2577	3442	3967	4341	4643	4932	5224	5554	5931	6346	6845	7479	8235	9516	10921	13033	15277	17449	18.00	
18.50	110	2286	2979	3414	3673	3815	3893	3951	4012	4115	4320	4603	4959	5458	6511	7872	10049	12543	15057	17488	18.50
19.00	112	1982	2596	2988	3195	3258	3215	3104	2954	2804	2723	2710	2780	3087	3833	4987	7036	9433	11867	14527	19.00
19.50	-	1538	2160	2550	2778	2891	2894	2784	2569	2231	1760	1385	1247	1279	1685	2532	4262	6237	8428	10884	19.50
F.P	-	-	1195	1825	2310	2652	2859	2901	2768	2497	2060	1301	-	29	148	603	1551	2981	4700	6815	F.P
20.23	-	-	-	1353	2045	2481	2753	2893	2890	2686	2125	697	-	-	-	-	-	1590	3135	5042	20.23
20.45	-	-	-	-	-	1300	1910	2258	2420	2400	2110	1320	-	-	-	-	-	-	-	2343	20.45
20.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.68

# Step 4: Calculation of the Sectional Area and the Water Plane Area

## - Water Plane Area

### ☑ Example

- Draft to be calculated: 5.0 W.L
- Water line to be calculated: 5.0 W.L
- Half-breads of all stations for 5.0 W.L

STA. NO.	OFF-SETS TABLE																				STA. NO.
	BOTTOM LINE	1.00 W.L	2.00 W.L	3.00 W.L	4.00 W.L	5.00 W.L	6.00 W.L	7.00 W.L	8.00 W.L	9.00 W.L	10.00 W.L	11.00 W.L	12.00 W.L	13.00 W.L	14.50 W.L	16.00 W.L	18.00 W.L	20.00 W.L	22.00 W.L	24.20 W.L	
Trans. (-0.38)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14450	18262	19780	20000	20000	Trans. (-0.38)
-0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10525	15955	18890	19944	20000	20000	-0.19
A.P	-	-	-	-	-	-	-	-	-	-	-	-	-	2627	12572	16765	19204	19994	20000	20000	A.P
0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	8474	14763	17871	19596	20000	20000	20000	0.25
0.50	-	-	-	-	-	-	-	-	-	-	-	-	3283	11746	16178	18456	19824	20000	20000	20000	0.50
0.75	-	-	-	487	933	530	-	-	-	-	0	1846	8680	13817	17230	18948	19956	20000	20000	20000	0.75
1.00	-	93	1802	1870	1462	863	397	183	280	895	2275	5061	12168	15561	18071	19440	20000	20000	20000	20000	1.00
1.50	49	1879	2372	2520	2446	2215	2059	2283	2919	4288	9026	13623	16033	17687	19196	19906	20000	20000	20000	20000	1.50
2.00	534	2677	3363	3734	3932	4029	4250	5085	7289	10680	13943	16341	17896	18937	19811	20000	20000	20000	20000	20000	2.00
3.00	2025	5058	6294	7228	8182	9483	11583	14000	16000	17469	18517	19244	19735	19990	20000	20000	20000	20000	20000	20000	3.00
4.00	3974	8451	10473	12071	13627	15218	16635	17938	18937	19594	19941	20000	20000	20000	20000	20000	20000	20000	20000	20000	4.00
5.00	6091	12054	14349	16032	17344	18359	19152	19729	19996	20005	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	5.00
6.00	8152	14697	16708	18069	19011	19627	19952	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	6.00
7.00	10187	16515	18101	19113	19728	19985	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	7.00
8.00	12286	17500	18738	19502	19915	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	8.00
9.00	13900	17562	18720	19408	19815	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9.00
10.00	13517	17469	18718	19466	19926	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	10.00
11.00	12406	16799	18306	19265	19873	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11.00
12.00	11001	15632	17338	18464	19316	19887	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	12.00
13.00	9018	14029	15875	17152	18138	18941	19528	19922	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13.00
14.00	6196	11304	13404	14934	16146	17141	17974	18650	19199	19622	19886	19994	20000	20000	20000	20000	20000	20000	20000	20000	14.00
15.00	2993	7980	10216	11870	13217	14356	15353	16246	17038	17740	18354	18842	19312	19633	19929	20000	20000	20000	20000	20000	15.00
16.00	583	5356	7103	8420	9598	10677	11684	12651	13581	14471	15328	16159	16935	17624	18572	19322	19877	20000	20000	20000	16.00
17.00	124	3602	4805	5656	6434	7181	7919	8674	9438	10248	11052	11859	12734	13663	15032	16321	17837	19014	19797	20000	17.00
18.00	100	2577	3442	3967	4341	4643	4932	5224	5554	5931	6346	6845	7479	8197	9037	10216	11867	13303	15277	17449	18.00
18.50	110	2286	2979	3414	3673	3815	3893	3951	4012	4115	4320	4603	4959	5458	6511	7872	10049	12543	15057	17488	18.50
19.00	112	1982	2596	2988	3195	3258	3215	3104	2954	2804	2723	2710	2780	3077	3833	4987	7036	9433	11867	14527	19.00
19.50	-	1538	2160	2550	2778	2891	2894	2784	2569	2231	1760	1385	1247	1279	1685	2532	4262	6237	8428	10884	19.50
F.P	-	-	1195	1825	2310	2652	2859	2901	2768	2497	2060	1301	-	29	148	603	1551	2981	4700	6815	F.P
20.23	-	-	-	1353	2045	2481	2753	2893	2890	2686	2125	697	-	-	-	-	1590	3135	5042	20.23	
20.45	-	-	-	-	-	1300	1910	2258	2420	2400	2110	1320	-	-	-	-	-	2343	20.45		
20.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.68

# Step 5: Calculation of the Displacement Volume and the 1<sup>st</sup> Moment of the Displacement Volume

- ✓ We can calculate the displacement volume and the 1<sup>st</sup> moment of the displacement volume from the sectional area for each station ("longitudinal integration") or from the water plane area for each water line ("vertical integration")

