

Computer Aided Ship Design

Part II. Curve and Surface Modeling

Term Project

September, 2013

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Computer Aided Ship Design, II-5. Term Project, Fall 2013, Myung-Il Roh



Term Project

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Overview (1/3)

✓ Objective

- To develop a program for visualize the lines(body plan) of a ship by using cubic B-spline curves

✓ Curve Modeling Method

■ Curve interpolation by using cubic B-spline

- Given: Points on the curve (P_i)
- Find: B-spline control points (d_i)

$$\mathbf{r}(u) = \mathbf{d}_0 N_0^3(u) + \mathbf{d}_1 N_1^3(u) + \mathbf{d}_2 N_2^3(u) + \cdots + \mathbf{d}_{D-1} N_{D-1}^3(u)$$

where, d_i : Control points (**de Boor points**), $i = 0, 1, \dots, D-1$

$N_i^n(u)$: **B-spline basis function** of degree $n(=3)$

u_j : Knots, $j = 0, 1, \dots, K-1$

$$N_i^n(u) = \frac{u - u_{i-1}}{u_{i+n-1} - u_{i-1}} N_i^{n-1}(u) + \frac{u_{i+n} - u}{u_{i+n} - u_i} N_{i+1}^{n-1}(u)$$
$$N_i^0(u) = \begin{cases} 1 & \text{if } u_{i-1} \leq u < u_i \\ 0 & \text{else} \end{cases}, \sum_{i=0}^{D-1} N_i^n(u) = 1$$

Overview (2/3)

☑ Given

- Ship: 6,300TEU Container Ship
- Principal dimensions
 - LOA 278.05m, LBP 264.05m, B 40.0m, D 24.2m, Td 12.0m, Ts 14.5m
- Offsets table

☑ Requirements

- Section lines to be visualized in body plan
 - Station lines from A.P to F.P in offsets table
- Body plan
 - Left hand side: After body(A.P ~ St. 10)
 - Right hand side: Fore body(St. 10 ~ F.P.)

☑ Hints

- To calculate a parameter value(u_j) for each point, please use the method of “**Chord Length Parameters**”
- To calculate tangent vectors at the starting and end points(t_s , t_e), please use the method of “**Bessel End Condition**”.

Overview (3/3)

☑ Implementation

- Any program language (C++ [Recommended], FORTRAN) or tool (Matlab, MS Excel) can be used.
- An output of your program should be a text file which includes the result of curve interpolation.
- However, the grading is different according to the language or tool what you select.
- Introduce to your program and discuss its result in your report.
- You can refer materials on the internet, but **do not copy!**

☑ Due date: 23:59 on 22nd December, 2013

☑ Submissions

- PDF file for body plan
- 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

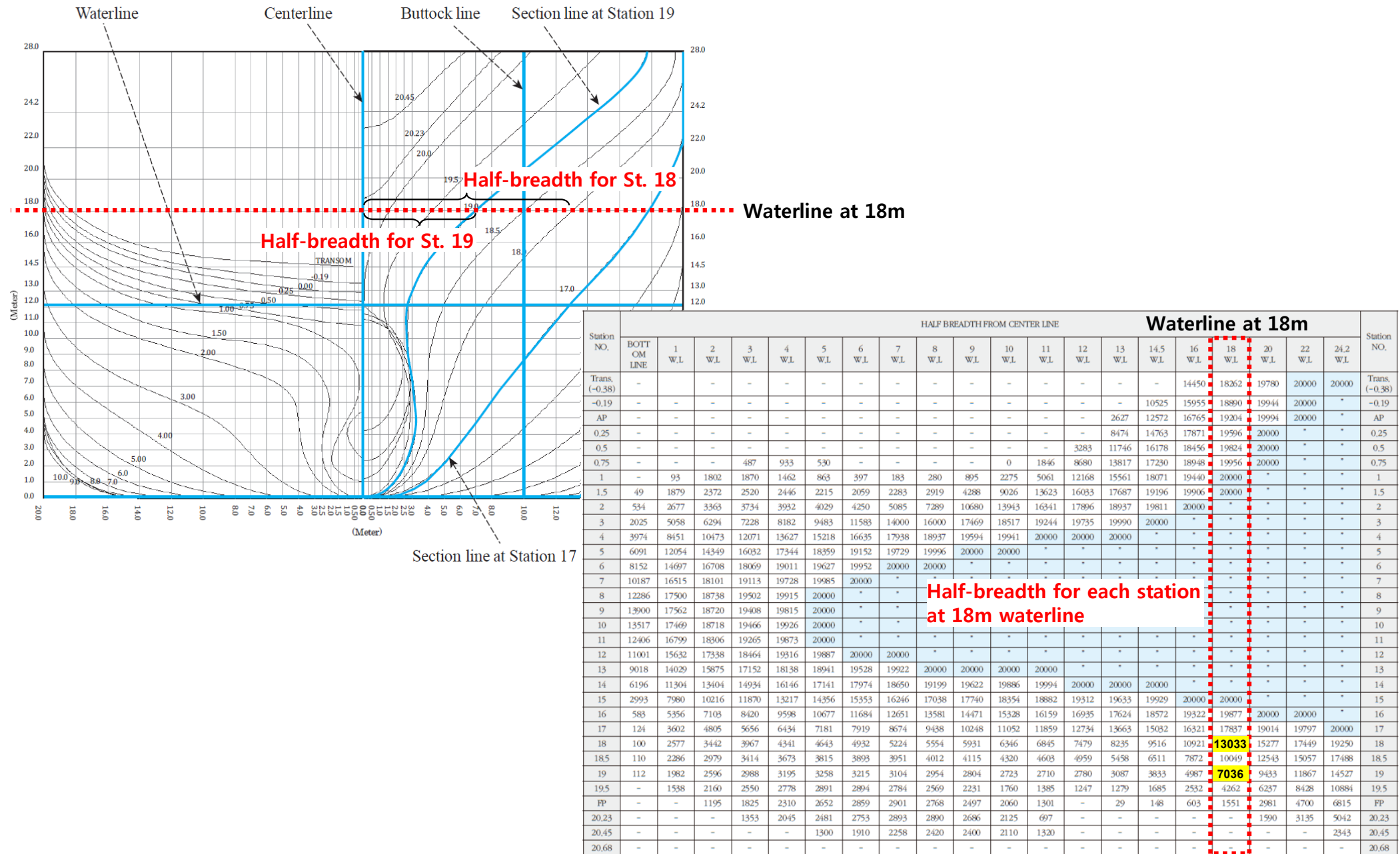
↓ Stations

Station NO.	HALF BREADTH FROM CENTER LINE																				Station NO.
	BOTTOM 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)

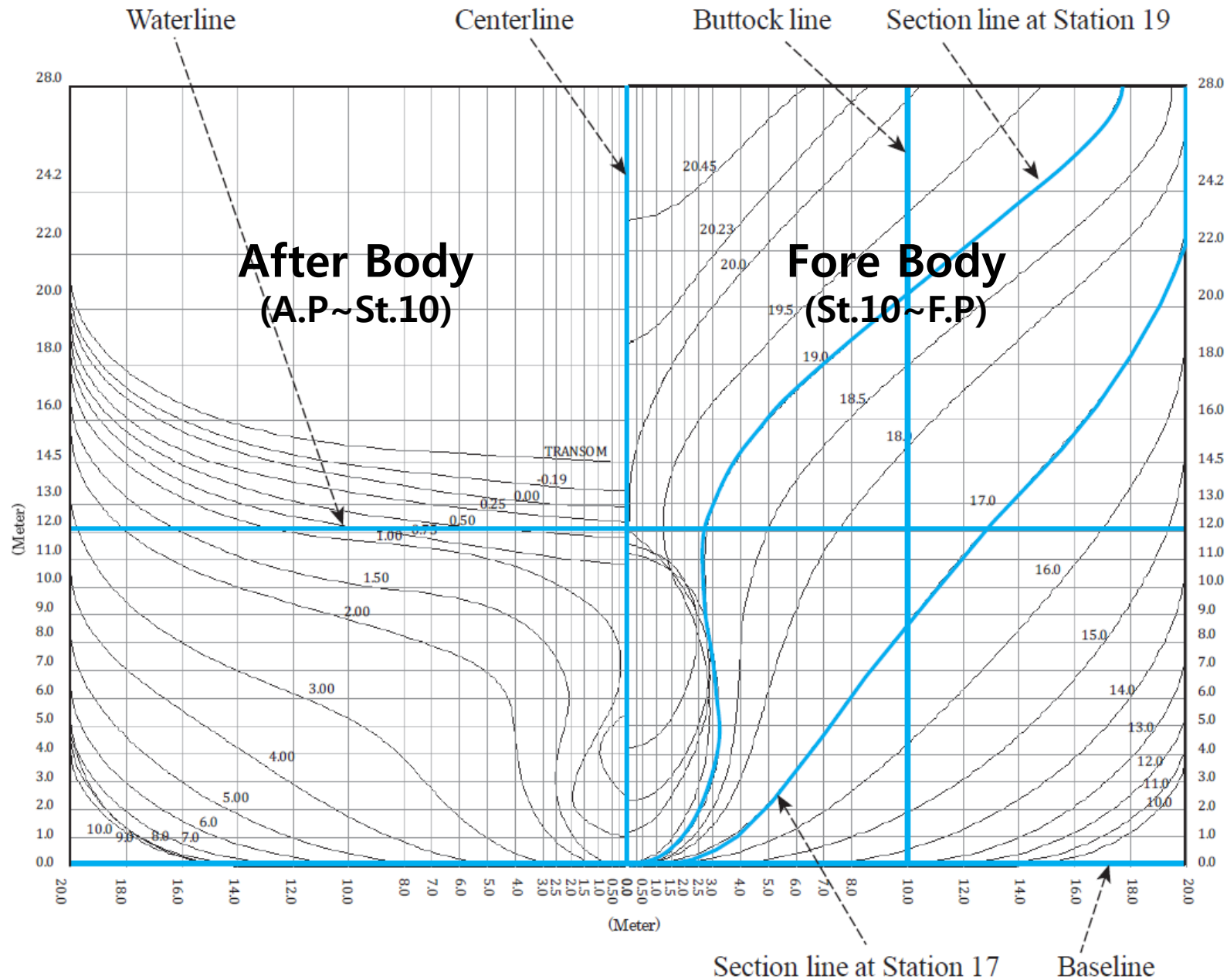
OFF-SETS TABLE																					
STA. NO.	HALF BREADTH FROM CENTER LINE																				STA. NO.
	BOTTOM LINE	1.00 W.L	2.00 W.L	3.00 W.L	4.00 W.L	5.00 W.L	6.00 W.L	7.00 W.L	8.00 W.L	9.00 W.L	10.00 W.L	11.00 W.L	12.00 W.L	13.00 W.L	14.50 W.L	16.00 W.L	18.00 W.L	20.00 W.L	22.00 W.L	24.20 W.L	
Trans. (-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

Relationship Between Lines and Offsets Table



Lines of a 6,300TEU Container Ship

- Body Plan



Method of Visualizing Curves (1/2)

- ☑ 1. Generate a text file which includes the result of curve interpolation(point group on each section line) from your program.
- ☑ 2. Change the extension of the file into "Filename.ps".
- ☑ 3. Execute "Filename.ps" and then the file will be converted into "Filename.pdf" through "Adobe Distiller".
 - In your computer, "Adobe Acrobat" should be installed. If not, please perform this step in computer room of our department.
- ☑ 4. Open "Filename.pdf" by using "Adobe Acrobat Reader" and then you can see the result.

Method of Visualizing Curves (2/3)

☑ Syntax for the text file

```
newpath  
x1 y1 moveto  
x2 y2 lineto  
x3 y3 lineto  
...  
xi yi lineto  
stroke
```

} For 1st Curve

```
newpath  
x1 y1 moveto  
x2 y2 lineto  
x3 y3 lineto  
...  
xi yi lineto  
stroke  
...
```

} For 2nd Curve

Method of Visualizing Curves (3/3)

☑ Example of the text file

```
newpath  
P11x P11y moveto  
P12x P12y lineto  
P13x P13y lineto  
P14x P14y lineto  
stroke
```

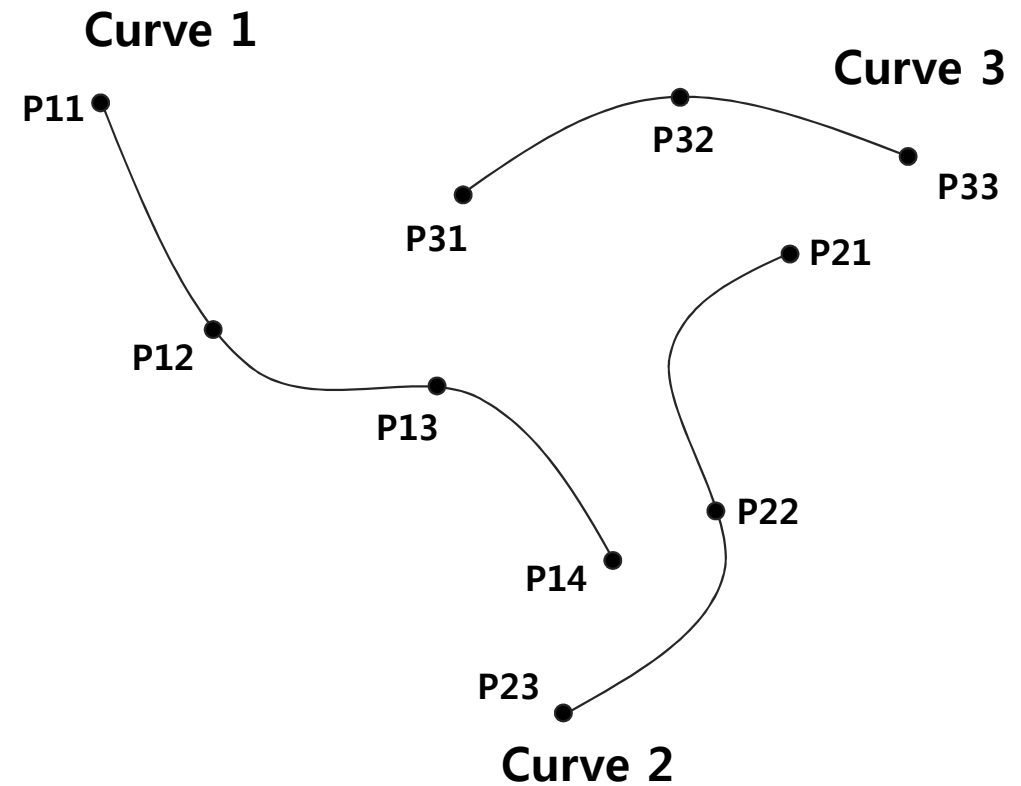
} For Curve 1

```
newpath  
P21x P21y moveto  
P22x P22y lineto  
P23x P23y lineto  
stroke
```

} For Curve 2

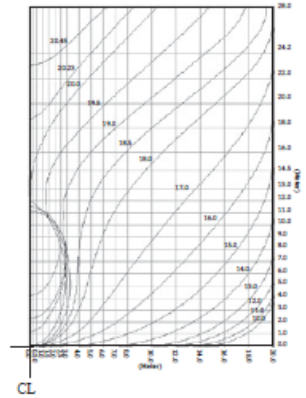
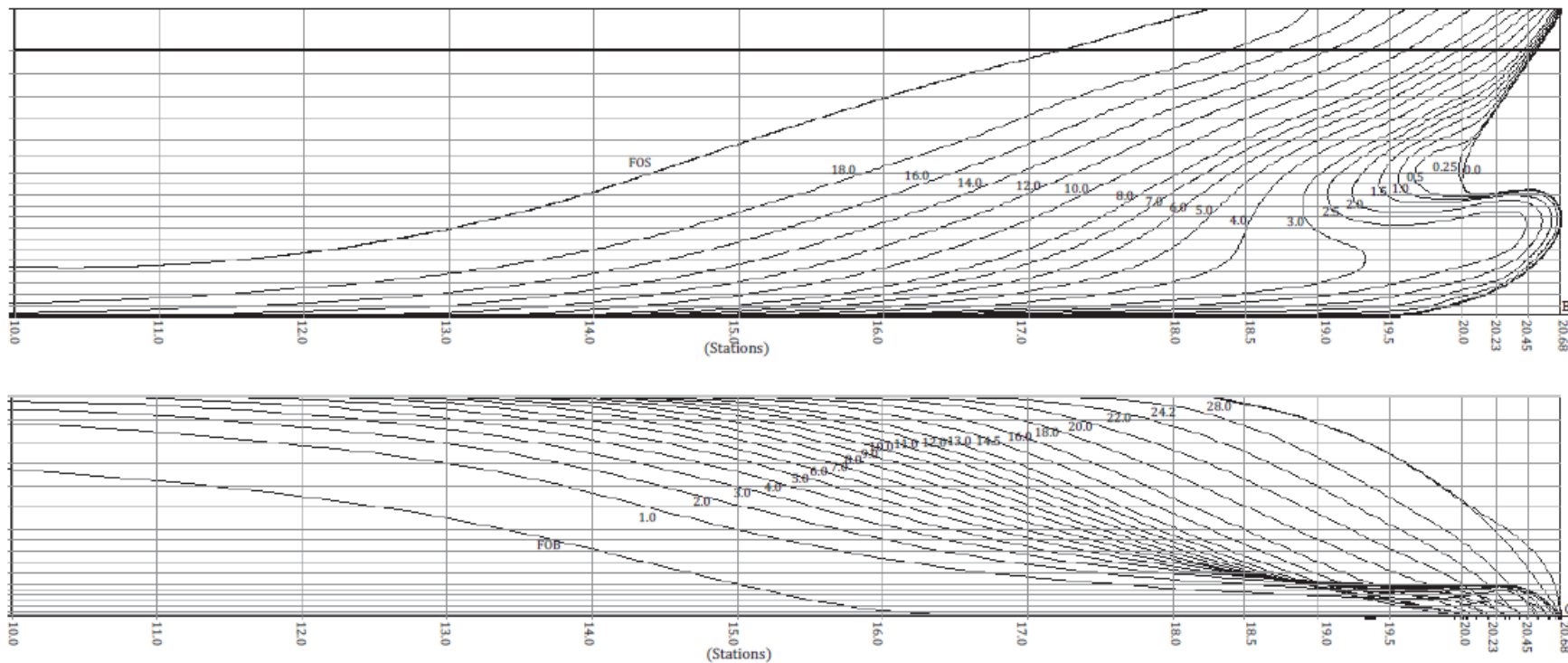
```
newpath  
P31x P31y moveto  
P32x P32y lineto  
P33x P33y lineto  
stroke
```

} For Curve 3

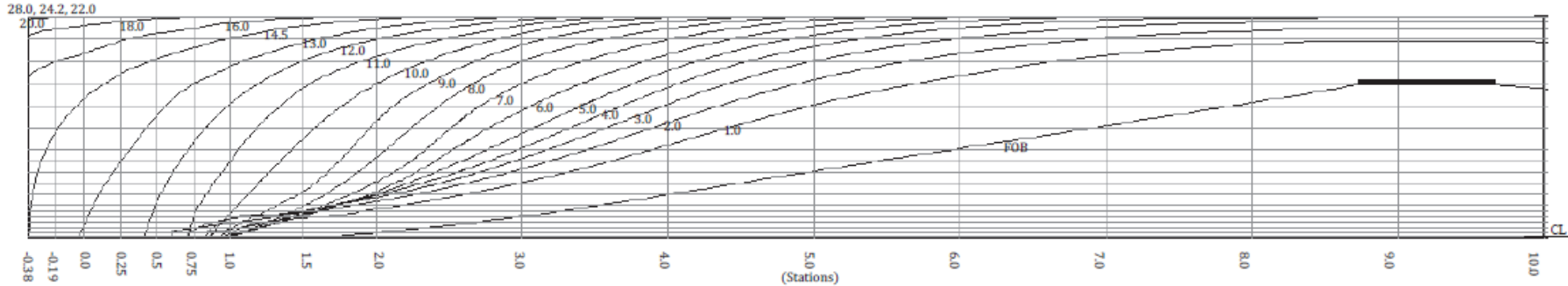


[Reference] Lines of a 6,300TEU Container Ship

- 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.mls (m)	14.5



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 mls (m)	14.5