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船舶の主要諸元の基準に関する研究

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National Institute for Land and Infrastructure Management
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Synopsis

Important conditions that are applied to plan and design mooring facilities, fairways, and other port facilities are the overall length, maximum draft and other dimensions of the design ship. If the design ship can be specified, it is possible to set its dimensions as conditions. But in fact, only conditions such as the category and size (DWT or GT) of the design ship can be provided, and designers must estimate the dimensions of the ship through a variety of conditions based on these conditions.

In order to respond appropriately to this situation, Japan's Technical Standards and Commentaries of Port and Harbor Facilities statistically analyze ship dimension data to stipulate the dimensions such as overall length and beam according to the size of the ship for every category of ship.

This report presents the results of research on ship dimensions and the Standards for the Main Dimensions of Ships (Draft) based on statistical analysis carried out by the Port Planning Division, Port and Harbour Department, National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport in preparation for the revision of the Technical Standards and Commentaries of Port and Harbor Facilities (scheduled for 2006).

Key Words：Technical Standards and Commentaries of Port and Harbour Facilities, Main dimensions of Design Ship, Statistical analysis

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船舶の主要諸元の基準に関する研究

高橋宏直*・後藤文子** ・安部智久***

要　旨

係留施設，航路等の港湾施設を計画・設計する場合に，対象船舶の船長，満載喫水等の諸元は重要な条件となる．ここで，対象船舶を特定できる場合にはその船舶の諸元を条件とすることができる．しかしながら，現実的には対象船舶の種類と規模（DWT or GT）程度の条件しか与えられず，この条件から様々な手法により船舶の諸元を推計せざるを得ない状況である．

こうした状況に適切に対処するために，日本の「港湾の施設の技術上の基準・同解説」では，船舶の諸元データを統計解析し，船舶の種類ごとに，船舶の規模に応じた船長，船幅等の諸元値を提示している．

本論文は，「港湾の施設の技術上の基準・同解説」の改訂（2006 年予定）に向けて，国土交通省国土技術政策総合研究所港湾研究部港湾計画研究室において実施した統計解析による船舶諸元に関する研究成果および「船舶の主要諸元に関する基準（案）」を提示している．

キーワード：港湾の施設の技術上の基準・同解説，船舶の主要諸元，統計解析

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Contents

1. Introduction

Important conditions that are applied to plan and design mooring facilities, fairways, and other port facilities are the length over all, full load draft and other dimensions of the design ship. If the design ship can be specified, it is possible to set its dimensions as conditions. But in fact, only conditions such as the category and size (DWT or GT) of the design ship can be provided, and designers must estimate the dimensions of the ship through a variety of conditions based on these conditions.

In order to respond appropriately to this situation, Japan's Technical Standards and Commentaries of Port and Harbor Facilities[1] statistically analyze ship dimension data to stipulate the dimensions such as length over all and breadth molded according to the size of the ship for every category of ship.

This report presents the results of research[2] on ship dimensions and the Standards for the Main Dimensions of Ships (Draft) based on statistical analysis carried out by the Port Planning Division, Port and Harbour Department, National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport in preparation for the revision of the Technical Standards and Commentaries of Port and Harbor Facilities (scheduled for 2006). Therefore the contents of this report conform with the Concept of the Standards in Japan's Technical Standards and Commentaries of Port and Harbor Facilities.

2. Basic concepts of the analysis of the main dimensions

2.1 Data analyzed

The data used for the statistical analysis are Lloyd's Maritime Intelligence Unit Shipping Data (below called, "LMIU Data") for January 2004. This LMIU Data is data that was supplied by the LMIU Division of Informa PLC. **Figure 2-1** shows the relationship with the LMIU Division within Informa PLC.
An outline of each organization follows.

(1) Informa PLC

Informa PLC was founded by a merger of the LLP Group that is the publishing division of Lloyds Insurance with the IBC Group in 1998. The origin of the LLP Group dates back to 1734 in Edward Lloyd's Coffee House, the place where maritime information was exchanged, and where Lloyd's List, the world's first journal of maritime information, was posted on the wall.

It now provides technological, specialized, and business related special information and services throughout the world, and its range of concerns is extremely wide, including social science, natural science, finance, law, electrical communication, maritime transport, energy, agriculture, food products, and so on.

(2) Informa Maritime & Transport Division

The Informa Maritime & Transport Division is the division that handles maritime information for the entire group. It sells maritime information such as the Lloyd's List to corporations in 134 countries through a daily journal and as electronic data.

(3) LMIU Division

The LMIU Division has constructed its own data base of information concerning more than 117,000 oceangoing ships including those under construction, ships in service, and decommissioned ships, more than 163,500 maritime companies, and more than 8,000 ports around the world. It provides necessary data according to the desires of its customers.

In particular, it collects principal types of data concerning main dimensions every month from all the classification societies of the International Association of Classification Societies (IACS) and has constructed a vast database of data collected from other organizations. It also provides data from its database with contents adapted to the demands of its users.
Therefore, the LMIU Data (Jan. 2004) that were analyzed for this report are not an off-the-shelf package of data; rather the data were assembled according to items that the Port Planning Division, Port and Harbour Department, National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport requested from the LMIU.

The LMIU constantly updates its data and corrects,

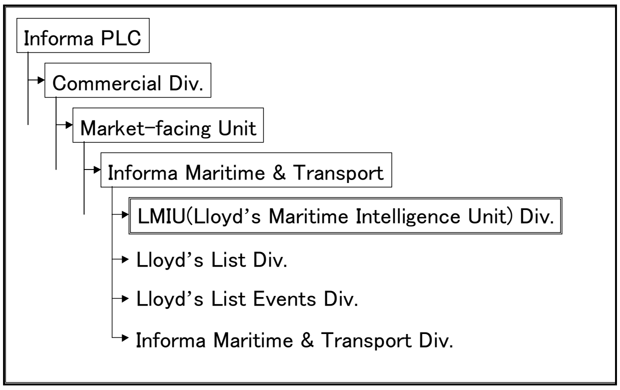


Figure 2-1 Lloyd's Maritime Intelligence Unit

updates, etc. past data, so even data regarding the same item in the same period varies according to the time it was ordered. Data concerning all items regarding the same ship is not necessarily presented, for example, in some cases, Loa is presented but not Lpp. It is assumed that some of the values are incorrect, so the analysis must be done with adequate care.

2.2 Ages of the ships analyzed

The statistical analysis was limited to ships with age of 15 years or less, for the following reasons.

1) Ships that cruise the world begin to be decommissioned about 25 years after completion, while Japan's Technical Standards and Commentaries of Port and Harbor Facilities are revised approximately every ten years, so the final period that the standards are applied should be ships up to the 25th year after their completion. Therefore, ship age up to 15 years (25 – 10) is considered to be the suitable analysis time.

2) Under Japan's Ministry of Finance statutes concerning the number of years of service of depreciable assets, the service life of a steel ship of 2,000 GT or more is 15 years. But because passenger ships are older than ordinary ships when they are decommissioned, ships up to 30 years were included in the analysis.

2.3 Categorization of design ships

(1) Categorization based on type of ship

Categorization of ships varies widely, according to the cargoes they carry, the method of loading cargoes, and ocean lane, so the finer the categorization, the more clearly their characteristics can be clarified. Because categorizing them in detail reduces the number of data handled by the statistical analysis, the precision of the analysis results is reduced.

So the following nine-type categorization is set based on Japan's existing Technical Standards and Commentaries of Port and Harbor Facilities.

"Cargo Ship" includes "General Cargo Ship" (ships that transport cargo in crates and barrels etc.), Bulk Carrier, and Ore Carrier.

1) Cargo Ship
2) Container Ship
3) Oil Tanker
4) Roll on/Roll off Ship
5) Pure Car Carrier
6) LPG Ship
7) LNG Ship
8) Passenger Ship
9) Ferry

(2) Number of ship data that are analyzed

The numbers of ship data analyzed by ship class by category of ship are shown in **Table 2-1**. It shows the numbers of data, relative ratio, cumulative ratio based on the same ship class (in the small scale, set in detail, and in large scale, set roughly) according to the ship categorization that has been established. These data are existing data; both DWT and GT data. And results for Cargo Ship include results categorized as "General Cargo Ship" and as "Bulk Carrier and Ore Carrier". The Vessel Type Decode that uses the LMIU Data ship categorization is shown in **Table 2-2**.

As a result, it has been clearly shown that the numbers of data for each category of ship vary greatly from 5,846 for Cargo Ship to 161 for LNG Ship and that the distributions are completely different between ship classes. Regarding cargo ships, it has been confirmed that below 15,000 DWT, many are general cargo ships and that at and above 15,000 DWT, many are bulk carries and ore carriers.

2.4 Analysis items

The following four items are established as the main dimensions according to the GT or the DWT classification of each category of ship analyzed in accordance with Japan's Technical Standards and Commentaries of Port and Harbor Facilities.

• Loa: Length over all
• Lpp: Length between perpendicular
• Breadth molded: B
• Full load draft: d

Table 2-1 Numbers of ship data analyzed by ship class by category of ship

DWT \ Type	Cargo Ship			Container Ship			Oil Tanker		
	N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio
0 — 499	74	1.3%	1.3%	0	0.0%	0.0%	0	0.0%	0.0%
500 — 999	136	2.3%	3.6%	0	0.0%	0.0%	0	0.0%	0.0%
1,000 — 1,999	462	7.9%	11.5%	1	0.0%	0.0%	4	0.4%	0.4%
2,000 — 2,999	425	7.3%	18.8%	7	0.3%	0.3%	2	0.2%	0.6%
3,000 — 4,999	946	16.2%	34.9%	82	3.5%	3.8%	3	0.3%	0.8%
5,000 — 9,999	902	15.4%	50.4%	371	15.7%	19.6%	5	0.5%	1.3%
10,000 — 14,999	159	2.7%	53.1%	259	11.0%	30.5%	1	0.1%	1.4%
15,000 — 29,999	673	11.5%	64.6%	592	25.1%	55.6%	7	0.7%	2.1%
30,000 — 49,999	687	11.8%	76.4%	520	22.1%	77.7%	4	0.4%	2.4%
50,000 — 99,999	971	16.6%	93.0%	499	21.2%	98.9%	212	19.9%	22.4%
100,000 — 199,999	382	6.5%	99.5%	27	1.1%	100.0%	446	41.9%	64.3%
200,000 —	29	0.5%	100.0%	0	0.0%	100.0%	380	35.7%	100.0%
Total	5,846	100.0%		2,358	100.0%		1,064	100.0%	

GT \ Type	Roll-on/Roll-off Ship			Pure Car Carrier			LPG Ship		
	N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio
0 — 499	59	11.8%	11.8%	1	0.5%	0.5%	46	4.5%	4.5%
500 — 999	44	8.8%	20.5%	1	0.5%	1.0%	218	21.5%	26.1%
1,000 — 1,999	42	8.4%	28.9%	4	1.9%	2.9%	94	9.3%	35.3%
2,000 — 2,999	33	6.6%	35.5%	0	0.0%	2.9%	101	10.0%	45.3%
3,000 — 4,999	35	7.0%	42.4%	1	0.5%	3.4%	191	18.9%	64.2%
5,000 — 9,999	110	21.9%	64.3%	22	10.7%	14.1%	138	13.6%	77.8%
10,000 — 14,999	41	8.2%	72.5%	5	2.4%	16.5%	35	3.5%	81.2%
15,000 — 29,999	96	19.1%	91.6%	24	11.7%	28.2%	62	6.1%	87.4%
30,000 — 49,999	17	3.4%	95.0%	58	28.2%	56.3%	123	12.1%	99.5%
50,000 — 99,999	25	5.0%	100.0%	90	43.7%	100.0%	4	0.4%	99.9%
100,000 — 199,999	0	0.0%	100.0%	0	0.0%	100.0%	1	0.1%	100.0%
200,000 —	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
Total	502	100.0%		206	100.0%		1,013	100.0%	

GT \ Type	LNG Ship			Passenger Ship			Ferry		
	N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio
0 — 499	1	0.6%	0.6%	61	16.0%	16.0%	145	63%	63%
500 — 999	2	1.2%	1.9%	18	4.7%	20.7%	44	19%	82%
1,000 — 1,999	1	0.6%	2.5%	34	8.9%	29.6%	12	5%	87%
2,000 — 2,999	1	0.6%	3.1%	13	3.4%	33.0%	17	7%	94%
3,000 — 4,999	0	0.0%	3.1%	29	7.6%	40.6%	8	3%	98%
5,000 — 9,999	0	0.0%	3.1%	42	11.0%	51.6%	5	2%	100%
10,000 — 14,999	0	0.0%	3.1%	31	8.1%	59.7%	0	0%	100%
15,000 — 29,999	9	5.6%	8.7%	30	7.9%	67.5%	0	0%	100%
30,000 — 49,999	11	6.8%	15.5%	37	9.7%	77.2%	0	0%	100%
50,000 — 99,999	77	47.8%	63.4%	72	18.8%	96.1%	0	0%	100%
100,000 — 199,999	59	36.6%	100.0%	15	3.9%	100.0%	0	0%	100%
200,000 —	0	0.0%	100.0%	0	0.0%	100.0%	0	0%	100%
Total	161	100.0%		382	100.0%		231	100.0%	

DWT / Type			General Cargo Ship			other General Cargo ship		
			N of data	Relative ratio	Cumulative ratio	N of data	Relative ratio	Cumulative ratio
0	−	499	73	2.3%	2.3%	1	0.0%	0.0%
500	−	999	135	4.2%	6.5%	1	0.0%	0.1%
1,000	−	1,999	449	14.0%	20.4%	13	0.5%	0.6%
2,000	−	2,999	402	12.5%	32.9%	23	0.9%	1.4%
3,000	−	4,999	926	28.8%	61.8%	20	0.8%	2.2%
5,000	−	9,999	876	27.3%	89.0%	26	1.0%	3.2%
10,000	−	14,999	124	3.9%	92.9%	35	1.3%	4.5%
15,000	−	29,999	176	5.5%	98.4%	497	18.9%	23.4%
30,000	−	49,999	38	1.2%	99.5%	649	24.7%	48.1%
50,000	−	99,999	15	0.5%	100.0%	956	36.3%	84.4%
100,000	−	199,999	0	0.0%	100.0%	382	14.5%	98.9%
200,000	−		0	0.0%	100.0%	29	1.1%	100.0%
Total			3,214	100.0%		2,632	100.0%	

Table 2-2 Vessel Type Decode

Type	Vessel Type Decode	
Cargo Ship	bulk	BBU
	ore carrier	BOR
	general cargo	GGC
Container Ship	container carrier	UCC
Oil Tanker	crude oil tanker	TCR
Roll-on/Roll-off Ship	ro/ro	URR
Pure Car Carrier	vehicle carrier	MVE
LPG Ship	lpg	LPG
LNG Ship	lng	LNG
Passenger Ship	passenger	MPR
Ferry	ferry	OFY

2.5 Analysis methods and coverage rate concept

(1) Analysis methods

The statistical analysis methods applied to obtain the main dimensions according to the ship class for each ship category are the following three types, and the optimum method is selected according to the data distribution properties in each case.

1) Logarithmic regression analysis method

i) Ships of the same category are spatially generally analogous regardless of their size, so their main dimensions are approximately proportional to 1/3 power of the ship size. The relationship of the main dimensions with the ship size is, therefore, represented by the following equation.

$$Y = \alpha X^{\beta} \tag{1}$$

Where:

Y : Loa, Lpp, B, d

X : GT, DWT

ii) Equation (1) is changed to equation (2) by transforming both sides into common logarithms, so that it is easy to perform statistical analysis such as calculating the simple linear regression equation and the standard differential.

$$\mathrm{Log}\ Y = \log \alpha + \beta \log\ X \tag{2}$$

Specifically, the results of the analysis of the category "Cargo Ship" are shown in **Figure 2-3**, **4**.

Figure 2-3 is a distribution diagram of Loa and DWT, and **Figure 2-4** shows the transformation of both axes into common logarithms. The analysis of the standard dimensions was done using a common logarithm with base of 10. In **Figure 2-4**, log (Loa) is clearly linear regressed based on log (DWT).

The actual analysis confirms high correlation: coefficient of determination (R^2) = 0.957, and β in equation 2 was confirmed to be a value near 0.295 and 1/3. In this report, in the representations of (log). the base is not

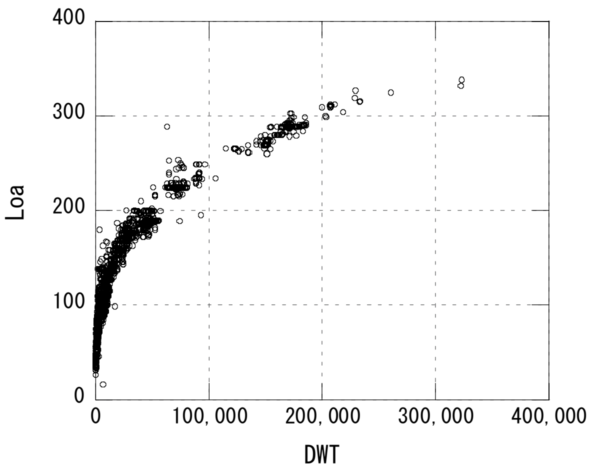


Figure 2-3 Cargo Ship Loa-DWT

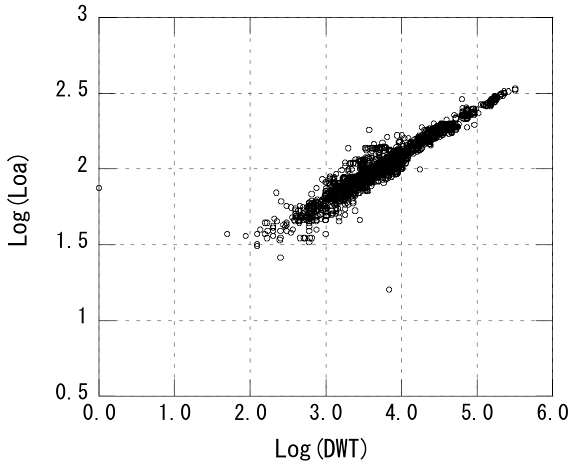


Figure 2-4 Cargo Ship Log(Loa)-Log(DWT)

written as ($\log_{10}$), but all signify a common logarithm.

2) Average value analysis method

The most conspicuous example of the application of this method is the B – DWT relationship for container ships shown in **Figure 2-5**. As this figure clearly shows, it is confirmed that up to about 35,000 DWT, as DWT increases, B also tends to rise, but afterwards it is constant. This is a result of the fact that because these travel through the Panama Canal, B is limited to the maximum value that can pass through this canal. Under these circumstances, the shape of ships is generally not spatially analogous, so it is not appropriate to apply 1) the logarithmic regression analysis method.

Therefore in a case where a dimension is constant regardless of the rise of GT and DWT in this way, the average value of the data that is analyzed is calculated at the same time as the standard differential from the standard value is analyzed. In this report, average value analysis is done to clearly differentiate this analysis method from the linear regression analysis method that

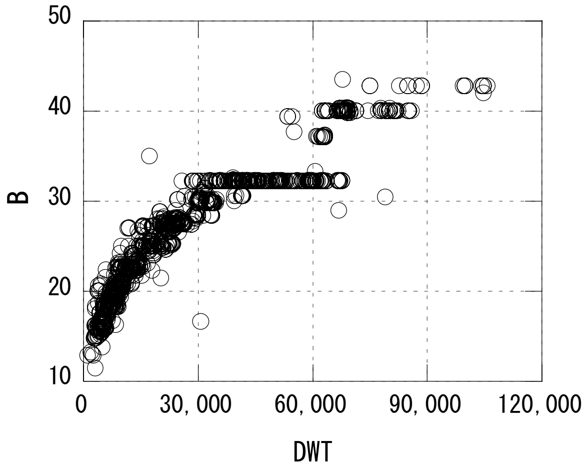


Figure 2-5 Container Ship B-DWT

follows.

3) Linear regression analysis method

The method of performing regression analysis based on a normal straight line without logarithmic conversion of the data is, in this paper, linear regression analysis. A representative example is the relationship of the number of containers that can be loaded on a container ship (TEU unit) with DWT that is shown in **Figure 2-6**. The actual analysis confirms good correlation: coefficient of determination (R^2) = 0.980.

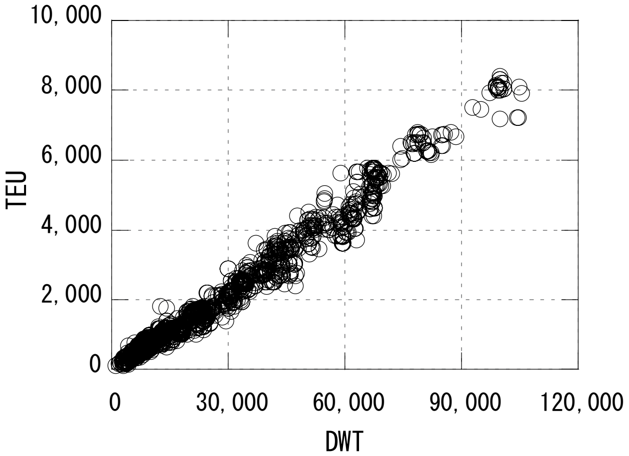


Figure 2-6　Container ShipTEU-DWT

(2) Analysis method selection concept

The analysis method is selected basically to ensure that the coefficient of determination (R^2) in the analysis results obtained by the analysis method that was selected is 0.64 or higher, in other words, that the coefficient of correlation (R) is 0.8 or more.

However, even though a value of 0.64 or higher is ensured as the coefficient of determination (R^2) based on the method that is applied, there are cases where it is judged that the properties of the main dimensions are not adequately reflected, or cases where there is a range where the correlation is remarkably low. Therefore, an appropriate method is selected for each dimension at the same time as a method is selected by appropriately distinguishing ship classes.

Therefore, even when the category is identical, the analysis methods applied to each main dimension and the range of the ship classes to which each is applied vary.

(3) Coverage rate: concept and setting

The values of Loa, Lpp, B, and d obtained by regression equations adapted to GT and DWT by each of the analysis methods shown above are average values (50% values). In other words, statistically, of the number of ships that were objects of analysis, less than 50% were below this average value and more than 50% were above this average value. The purpose of this research is to specify the standard main specifications according to ship size in a case where the size based on DWT or GT of ships that are analyzed is set, but the main dimensions are not specified. Therefore, it is not adequate for only about half of the number of ships to be covered by the main dimensions, and an important challenge is to answer the question: "Of all the ships corresponding to the set tonnage, what percentage should the value statistically cover?" The percentage it covers is the "coverage rate."

Because setting the coverage rate is an important factor in determining the level of service in a port, a port manager should set it based on his own concepts at the port facility planning and design stage. For example, in a case where the coverage rate is set at approximately 50%, mainly in order to lower port improvement costs, and ships with dimensions greater than this will enter the port, studying safety as necessary is considered. Another concept is, inversely, setting the coverage rate higher regardless of the higher cost to focus high service level on port sales.

It is possible to set a regression equation according to an optional coverage rate by assuming that the distribution of the data around the regression equation is a normal distribution, causing parallel translation of the regression equation of the average value based on the value obtained from the standard differential. The concept of this parallel translation is shown in **Figure 2-7** at the same time as this parallel translation quantity is calculated based on $k*\sigma$ (standard differential). The relationship of the value k with the coverage rate is

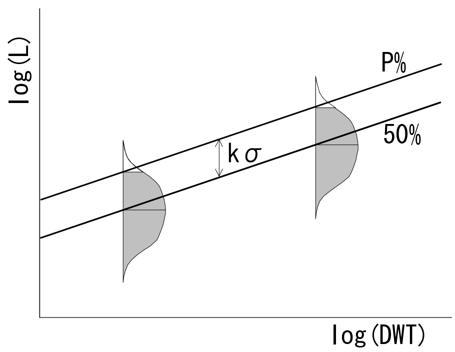


Figure 2-7　Line of P% coverage rate

shown in **Table 2-3**.

Under Japan's Technical Standards and Commentaries of Port and Harbor Facilities, the coverage rate had been 75%, so in this paper specific analysis is done for a coverage rate of 75%. But because the results of individual analyses show both regression equation and standard differential of the average value, it is possible to find a regression equation corresponding to an optional coverage rate.

Table 2-3 Relation between coverage rate and k

P	50%	60%	75%	90%	95%	99%
k	0.000	0.253	0.674	1.282	1.645	2.326

2.6 Setting the ship classes

The ship classes whose main dimensions are analyzed are shown on a table appropriately set by category of ship, based on the characteristics of each type of ship, values stipulated by Japan's former Technical Standards and Commentaries of Port and Harbor Facilities and on the opinions of concerned organizations. But in this report, it is possible to calculate the main dimensions according to optional ship classes because individual analysis results show the regression equation of a coverage rate of 75%.

3. Analysis of the main dimensions of ships

The concept of selecting the analysis method for each ship category and each dimension, an analysis results diagram and the final regression equation that are the basis for judgments are presented below. Analysis results according to typical ship classes are presented on summary tables. It shows two regression lines of curved lines and straight lines on the figure of each analysis result (regression equations finally selected assuming the top part is 75% coverage rate and bottom part is 50% coverage rate).

Loa and Lpp show similar trends, so the same analysis method is selected for all ship classes. And there are characteristics dimension values in the ship classes that are the maximum class in each ship category, so in cases where the results are separated from the statistical analysis results, specifications for individual ships are especially presented.

3.1 Cargo Ship

Figure 3-1 to **Figure 3-3**show the results of analysis of Loa, B, and d for DWT. And the following are the analysis methods applied to each main dimension and the range of the ship classes to which each method was applied. And **Table 3-1** shows the results of analysis of each main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-4**,**5**)

All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.957 for Loa and R^2 = 0.963 for Lpp.

(2) B (**Figure 3-6**)

All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.951. For the 55,000DWT class and 70,000DWT class it was 32.3 m instead of the analytic value assuming they are Panamax type.

(3) d (**Figure 3-7**,**8**)

The ships were divided into two classes with 30,000DWT as the boundary and the logarithmic regression analysis method was applied to each class, obtaining R^2 = 0.847 for less than 30,000DWT and R^2 = 0.850 for 30,000DWT or more.

Table 3-1 The results of analysis of main dimensions (Cargo Ship)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
1,000	67	61	10.7	3.8
2,000	82	75	13.1	4.8
3,000	92	85	14.7	5.5
5,000	107	99	17.0	6.4
10,000	132	123	20.7	8.1
12,000	139	130	21.8	8.6
18,000	156	147	24.4	9.8
30,000	182	171	28.3	10.5
40,000	198	187	30.7	11.5
55,000	217	206	32.3	12.8
70,000	233	222	32.3	13.8
90,000	251	239	38.7	15.0
120,000	274	261	42.0	16.5
150,000	292	279	44.7	17.7

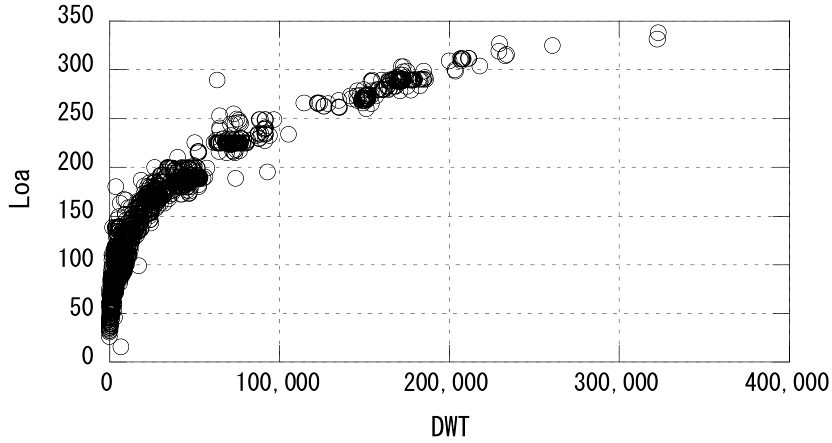


Figure 3-1 Cargo Ship Loa-DWT

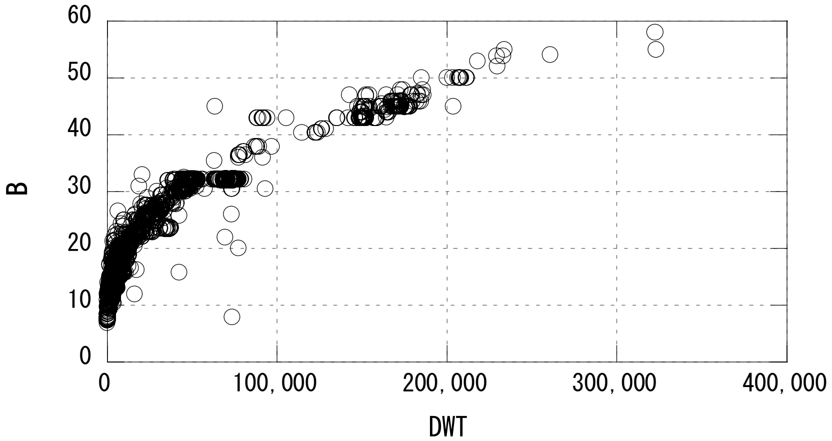


Figure 3-2 Cargo Ship B-DWT

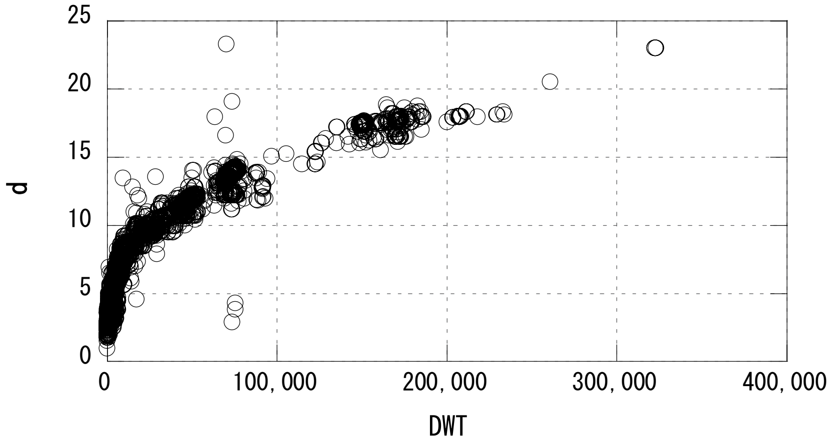
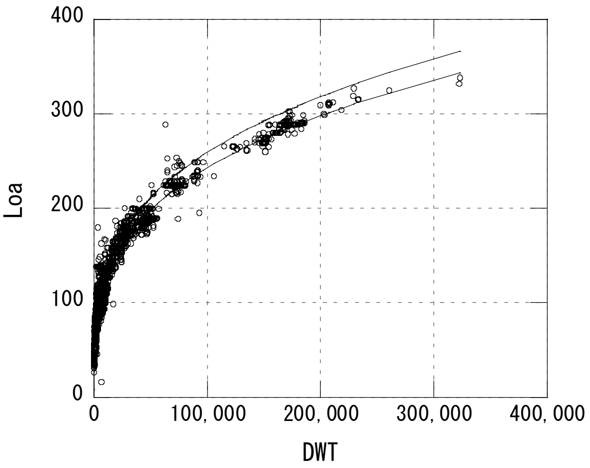
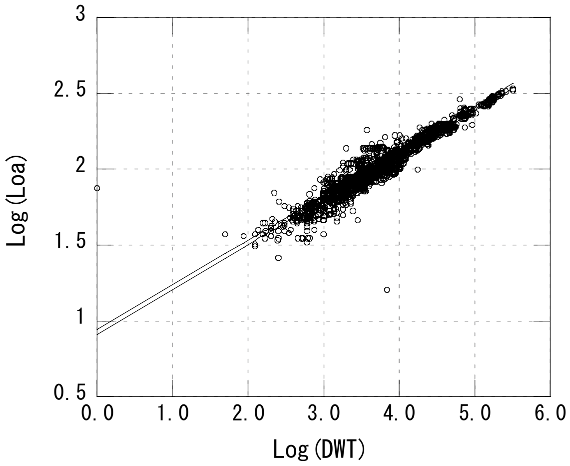


Figure 3-3 Cargo Ship d-DWT





$Y=\alpha \cdot X^{\beta}$

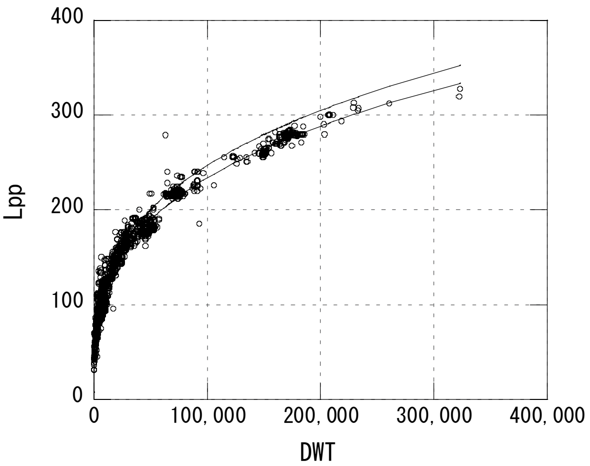
	50%	75%
α	8.1823	8.7338
β	0.2945	0.2945

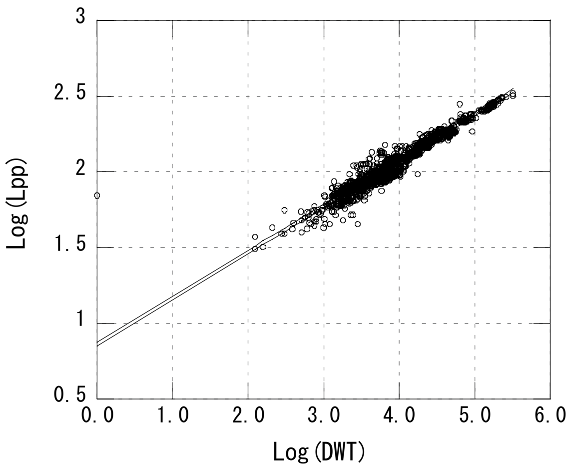
logY=a+blogX

(R^2= 0.957 , σ= 0.042)

	50%	75%
a	0.9129	0.9412
b	0.2945	0.2945

Figure 3-4 Cargo Ship Loa-DWT





$Y=\alpha \cdot X^{\beta}$

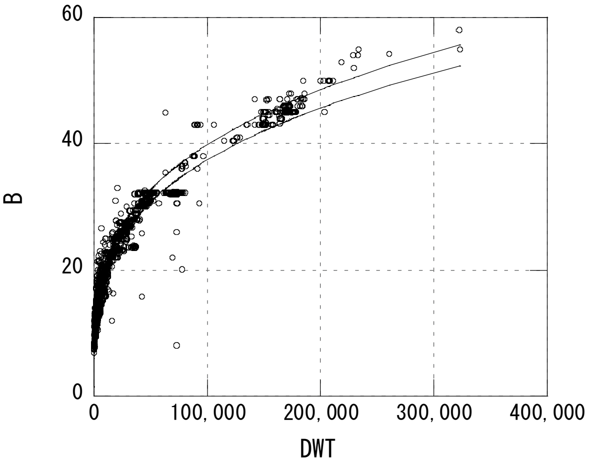
	50%	75%
α	7.0837	7.4863
β	0.3037	0.3037

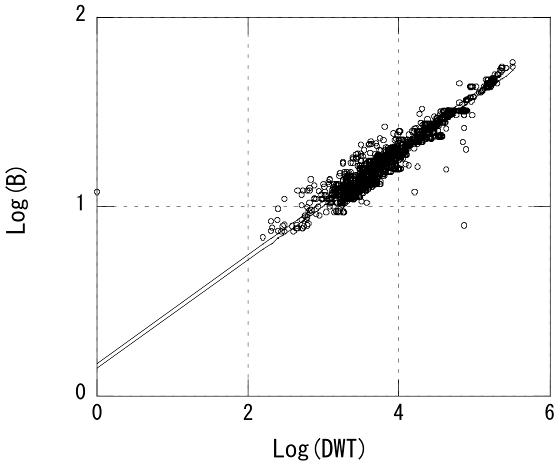
logY=a+blogX

(R^2= 0.963 , σ= 0.036)

	50%	75%
a	0.8503	0.8743
b	0.3037	0.3037

Figure 3-5 Cargo Ship Lpp-DWT





$Y=\alpha \cdot X^{\beta}$

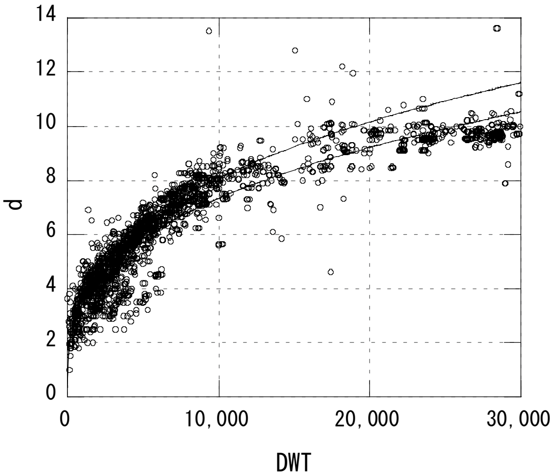
	50%	75%
α	1.4074	1.4974
β	0.2850	0.2850

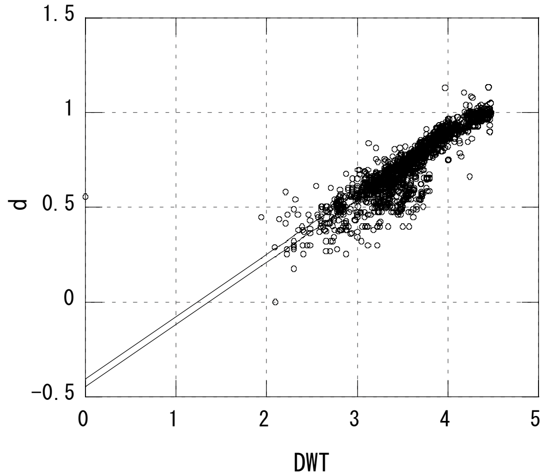
logY=a+blogX

(R^2= 0.951 , σ= 0.040)

	50%	75%
a	0.1484	0.1753
b	0.2850	0.2850

Figure 3-6 Cargo Ship B-DWT





$Y=\alpha \cdot X^{\beta}$

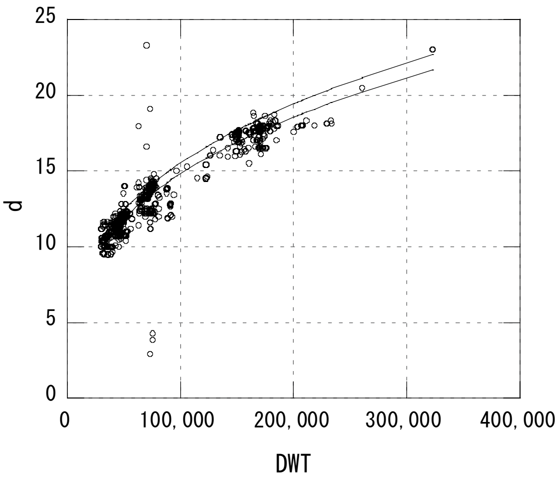
	50%	75%
α	0.3570	0.3935
β	0.3282	0.3282

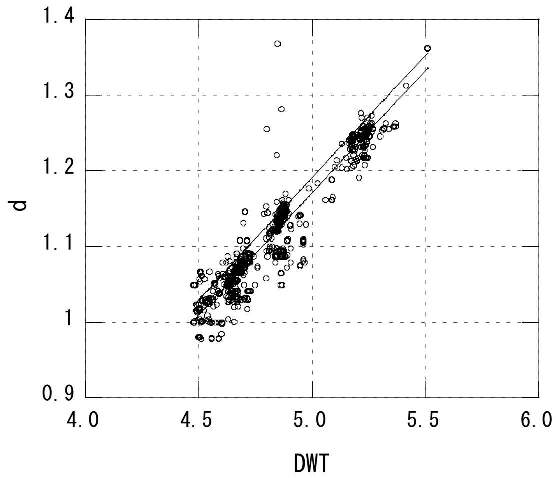
logY=a+blogX

(R^2= 0.847 , σ= 0.063)

	50%	75%
a	-0.4473	-0.4051
b	0.3282	0.3282

Figure 3-7 Cargo Ship（~Less than 30,000DWT）d-DWT





$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.3585	0.3754
β	0.3233	0.3233

$\log Y = a + b \log X$

(R^2= 0.850 , σ= 0.030)

	50%	75%
a	-0.4455	-0.4255
b	0.3233	0.3233

Figure 3-8 Cargo Ship（30,000DWT～） d-DWT

3.2 Container Ship

Figure 3-9 to **Figure 3-11** show the results of analysis of Loa, B, and d for DWT. For container ships, both an analysis of all ships, and analyses by dividing all ships into Under-PANAMAX , PANAMAX , and Over-PANAMAX were done. And the number of containers that can be loaded (TEU unit, below written "TEU") was analyzed and the results of analysis of TEU for DWT are also shown in **Figure 3-12**.

(1) Analysis encompassing all ships

All main dimensions, Loa, Lpp, B, and d were analyzed by dividing the ships into two classes at 35,000DWT and applying the logarithmic regression analysis method to those less than 35,000DWT. As a result, R^2 = 0.931 was obtained for Loa, R^2 = 0.933 for Lpp, R^2 = 0.918 for B, and R^2 = 0.930 for d. Then those of 35,000DWT or more were divided into 10,000DWT units as shown below, and analyzed by the average value analysis method. Because there are almost no data for ships of 85,000DWT or more but less than 95,000DWT, ships in these classes were not analyzed. **Figure 3-13** to **Figure 3-40** show results of analysis for each dimension. **Table 3-2** shows the results of analysis of each main dimension according to the ship classes that were set.

The value for B in the 40,000DWT class and the 50,000DWT class were, assuming they are Panamax type, set at 32.3m instead of an analytic value.

・35,000DWT or higher, less than 45,000DWT
・45,000DWT or higher, less than 55,000DWT
・55,000DWT or higher, less than 65,000DWT
・65,000DWT or higher, less than 75,000DWT
・75,000DWT or higher, less than 85,000DWT
・95,0000DWT or higher

Table 3-2 The results of analysis of main dimensions (Container Ship)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)	Reference：the number of containers that can be loaded (*TEU*)
10,000	139	129	22.0	7.9	500～ 890
20,000	177	165	27.1	9.9	1,300～1,600
30,000	203	191	30.6	11.2	2,000～2,400
40,000	241	226	32.3	12.1	2,800～3,200
50,000	274	258	32.3	12.7	3,500～3,900
60,000	294	279	35.9	13.4	4,300～4,700
100,000	350	335	42.8	14.7	7,300～7,700

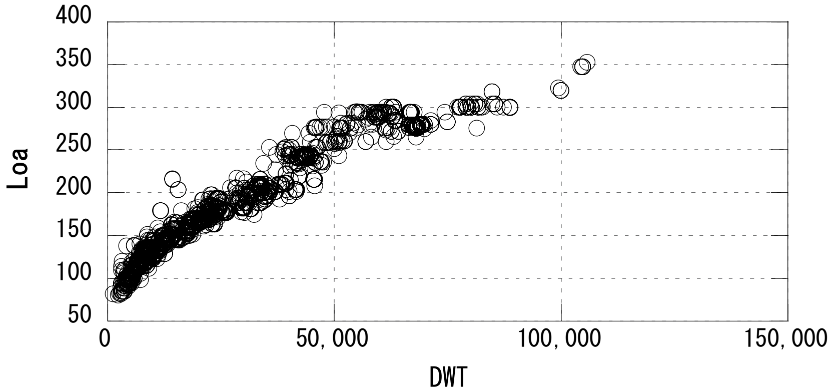


Figure 3-9 Container Ship Loa-DWT

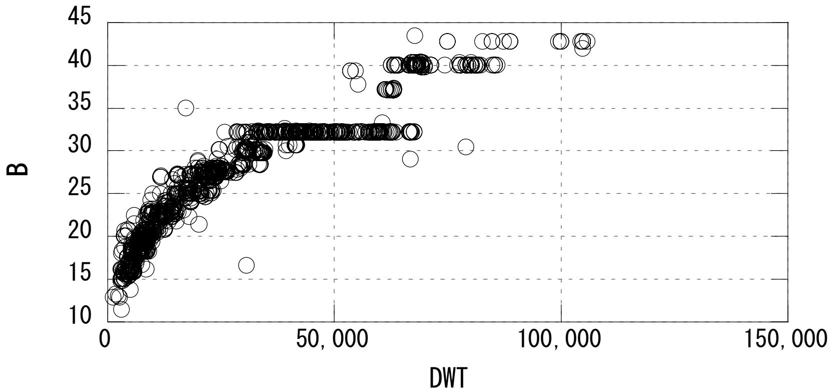


Figure 3-10 Container Ship B-DWT

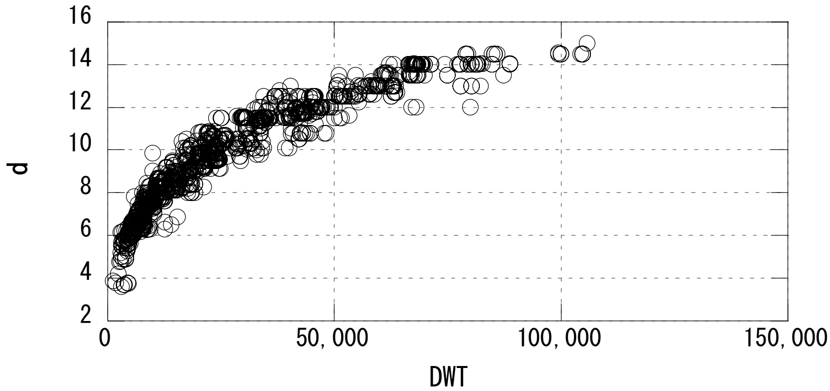


Figure 3-11 Container Ship d-DWT

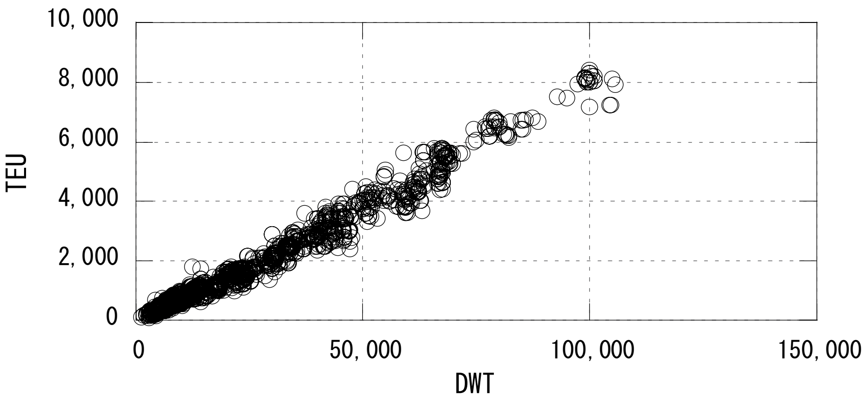
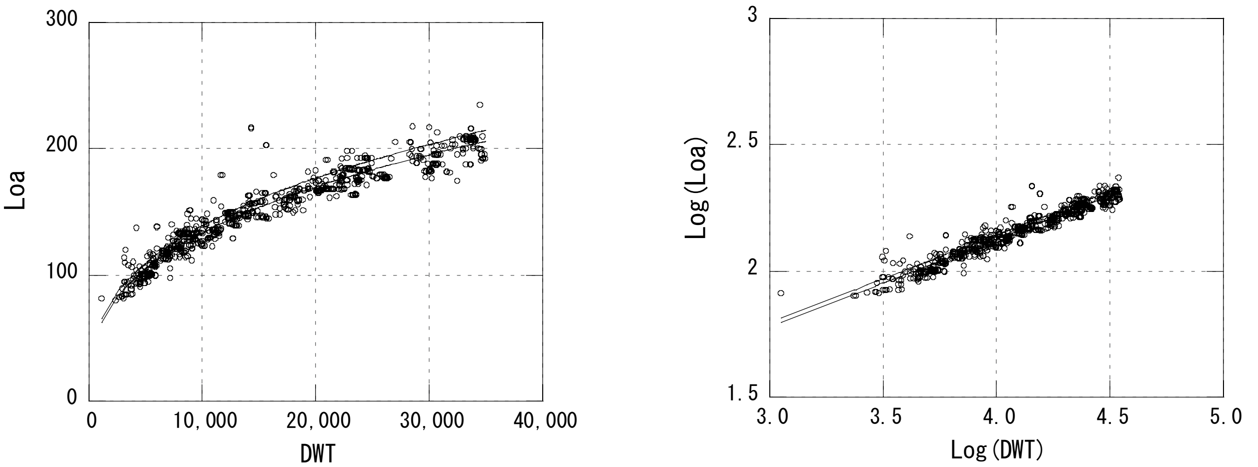


Figure 3-12 Container Ship TEU-DWT



$Y = \alpha \cdot X^{\beta}$

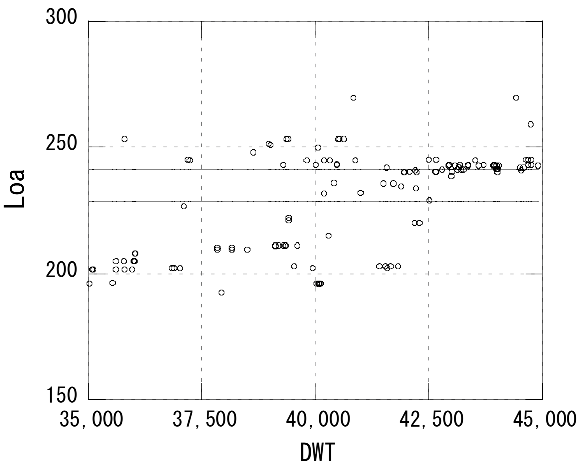
	50%	75%
α	5.4569	5.6834
β	0.3470	0.3470

$\log Y = a + b \log X$

(R^2= 0.931 , σ= 0.026)

	50%	75%
a	0.7369	0.7546
b	0.3470	0.3470

Figure 3-13 Container Ship（～Less thsn 35,000DWT）Loa-DWT

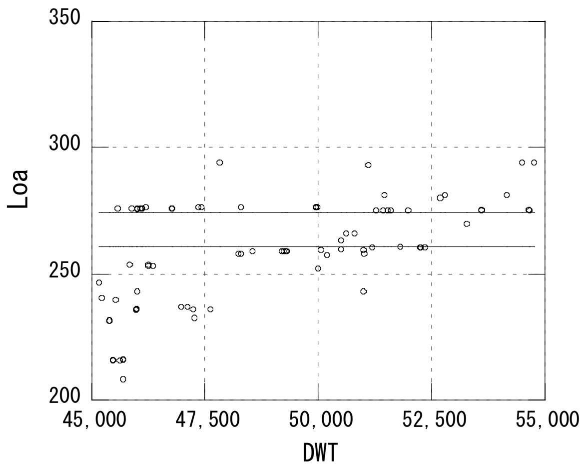


$Y = a_0$

（σ= 18.919 ）

	Average	75%
a_0	228.4	241.2

Figure 3-14 Container Ship
（35,000～Less than 45,000DWT）Loa-DWT

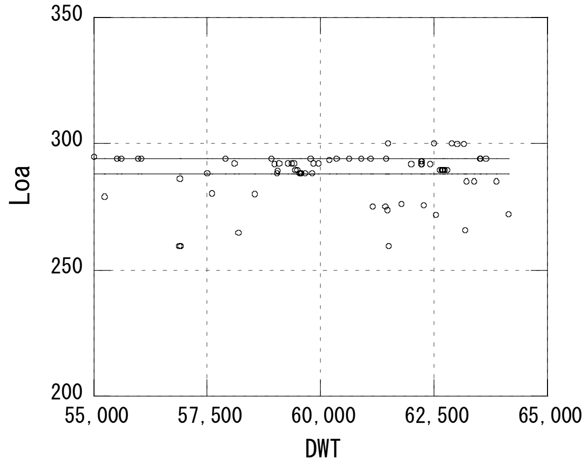


$Y = a_0$

（σ= 20.015 ）

	Average	75%
a_0	260.8	274.3

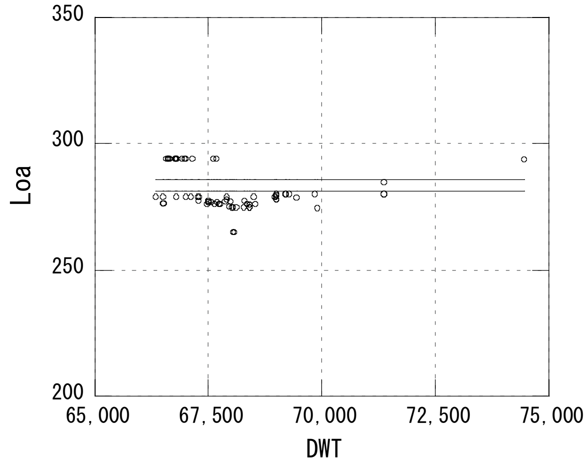
Figure 3-15 Container Ship
（45,000～Less than 55,000DWT）Loa-DWT



$Y=a_0$
(σ= 9.184)

	Average	75%
a_0	287.9	294.1

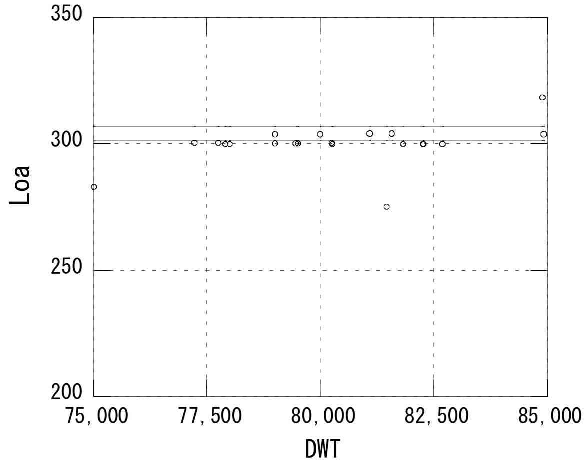
Figure 3-16 Container Ship
(55,000～Less than 65,000DWT) Loa-DWT



$Y=a_0$
(σ= 7.076)

	Average	75%
a_0	281.2	286.0

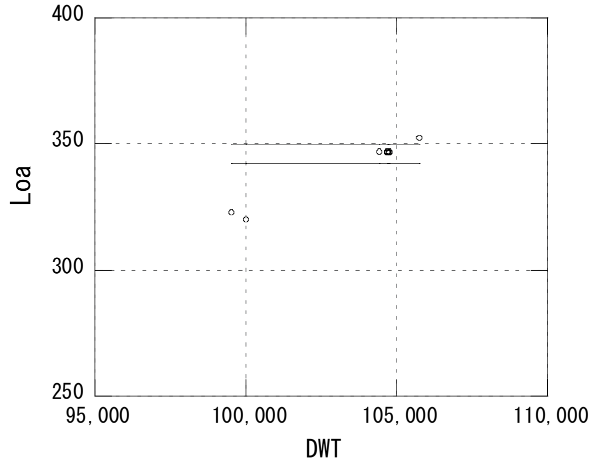
Figure 3-17 Container Ship
(65,000～Less than 75,000DWT) Loa-DWT



$Y=a_0$
(σ= 8.716)

	Average	75%
a_0	301.1	307.0

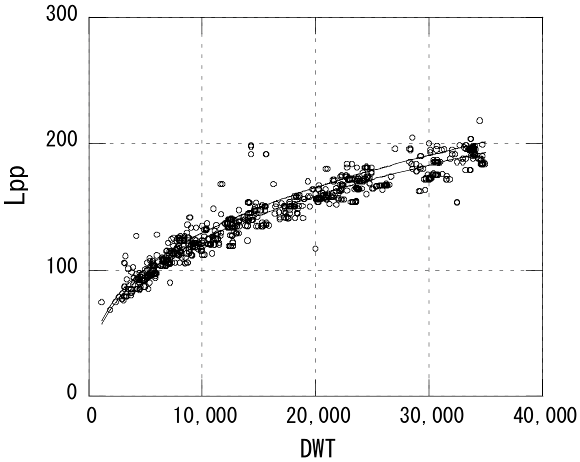
Figure 3-18 Container Ship
(75,000～Less than 85,000DWT) Loa-DWT



$Y=a_0$
(σ= 11.269)

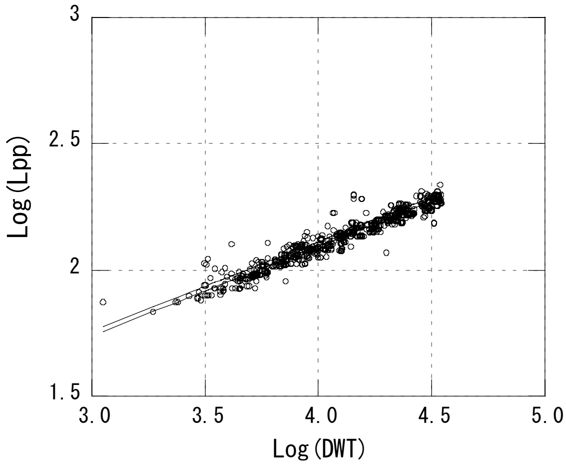
	Average	75%
a_0	342.3	349.9

Figure 3-19 Container Ship
(95,000DWT～) Loa-DWT



$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	4.7700	4.9714
β	0.3538	0.3538

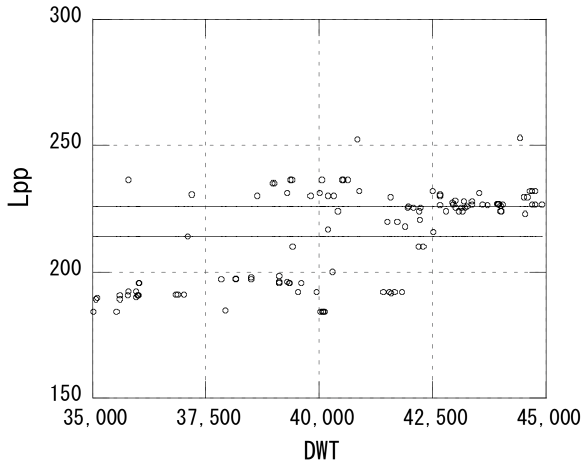


$\log Y = a + b \log X$

(R^2= 0.933 , σ= 0.027)

	50%	75%
a	0.6785	0.6965
b	0.3538	0.3538

Figure 3-20 Container Ship（～Less than 35,000DWT） Lpp-DWT

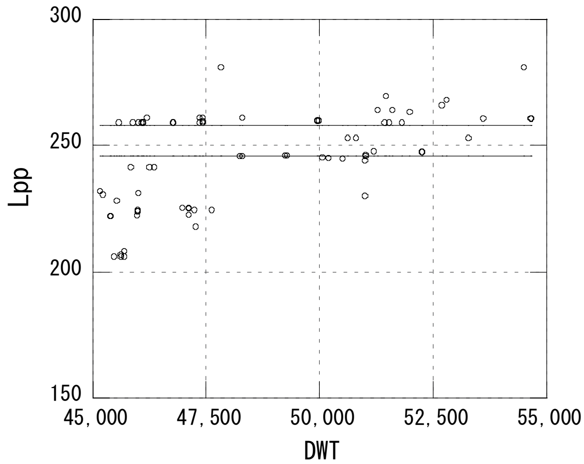


$Y=a_0$

（σ= 17.656 ）

	Average	75%
a_0	213.9	225.8

Figure 3-21 Container Ship（35,000～Less than 45,000DWT）Lpp-DWT

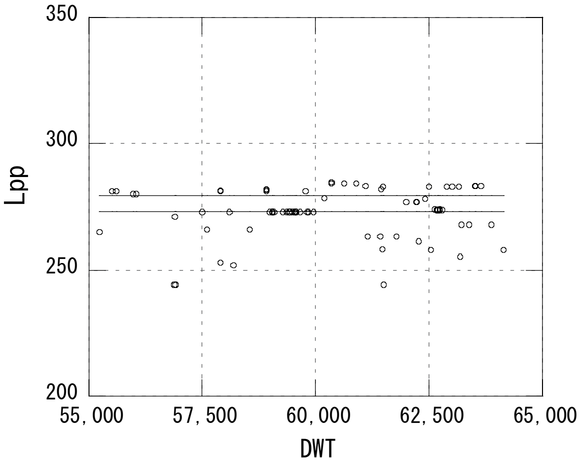


$Y=a_0$

（σ= 18.019 ）

	Average	75%
a_0	246.0	258.1

Figure 3-22 Container Ship（45,000～Less than 55,000DWT）Lpp-DWT

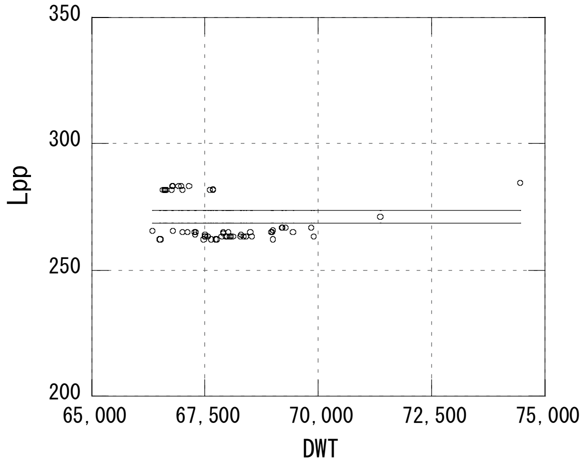


$Y=a_0$

(σ= 9.413)

	Average	75%
a_0	273.1	279.5

Figure 3-23 Container Ship
(55,000～Less than 65,000DWT) Lpp-DWT



$Y=a_0$

(σ= 7.761)

	Average	75%
a_0	268.4	273.6

Figure 3-24 Container Ship
(65,000～Less than 75,000DWT) Lpp-DWT

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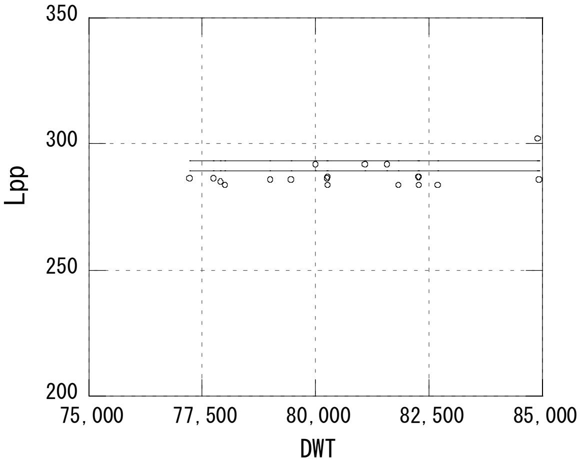
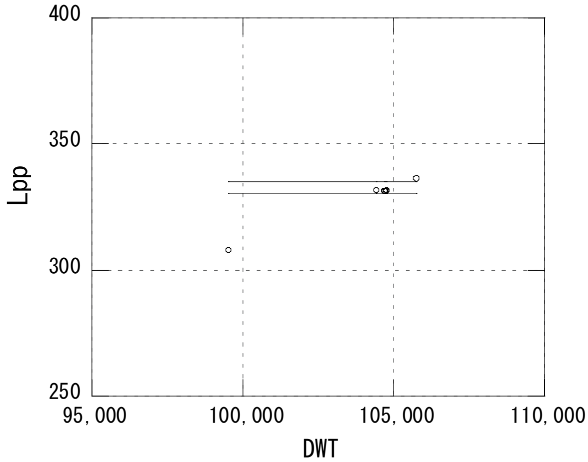


$Y=a_0$

(σ= 5.961)

	Average	75%
a_0	289.2	293.2

Figure 3-25 Container Ship
(75,000～Less than 85,000DWT) Lpp-DWT

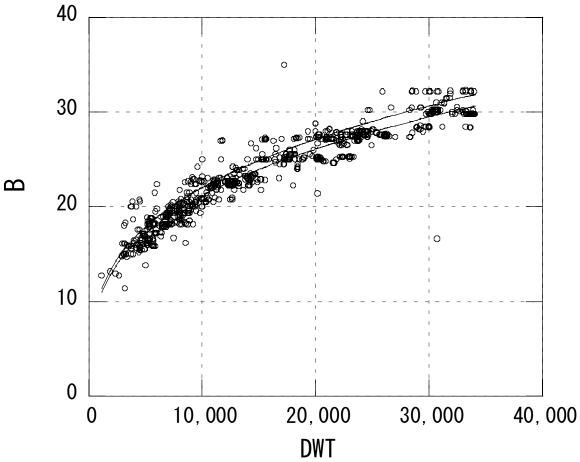


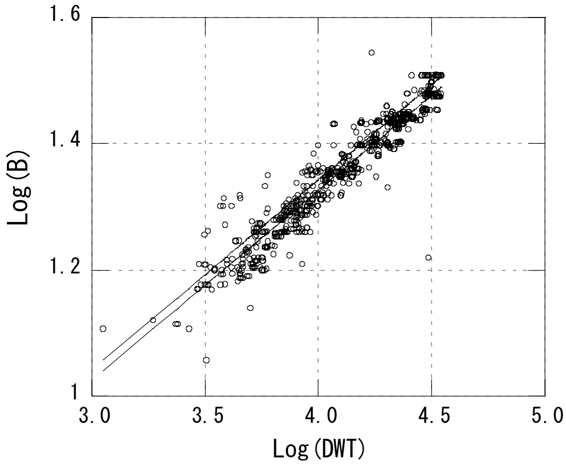
$Y=a_0$

(σ= 6.986)

	Average	75%
a_0	330.4	335.1

Figure 3-26 Container Ship
(95,000DWT～) Lpp-DWT





$Y=\alpha \cdot X^{\beta}$

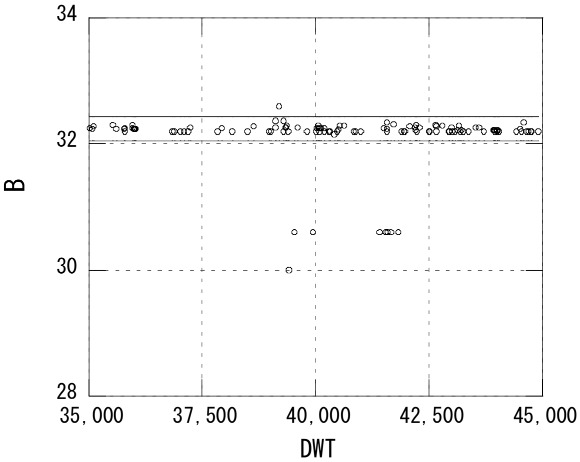
	50%	75%
α	1.3229	1.3750
β	0.3011	0.3011

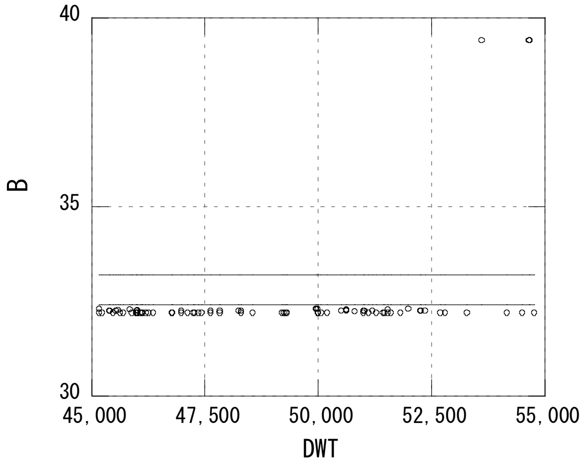
$\log Y = a + b \log X$

(R^2= 0.918 , σ= 0.025)

	50%	75%
a	0.1215	0.1383
b	0.3011	0.3011

Figure 3-27 Container Ship（～Less than 35,000DWT） B-DWT





$Y=a_0$

（σ= 0.569 ）

	Average	75%
a_0	32.0	32.4

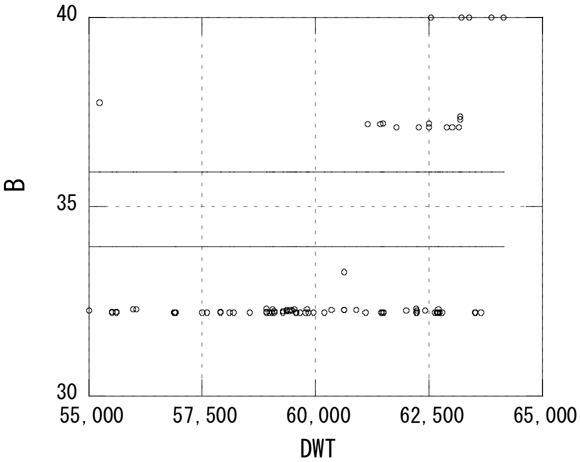
Figure 3-28 Container Ship
（35,000～Less than 45,000DWT）B-DWT

$Y=a_0$

（σ= 1.176 ）

	Average	75%
a_0	32.4	33.2

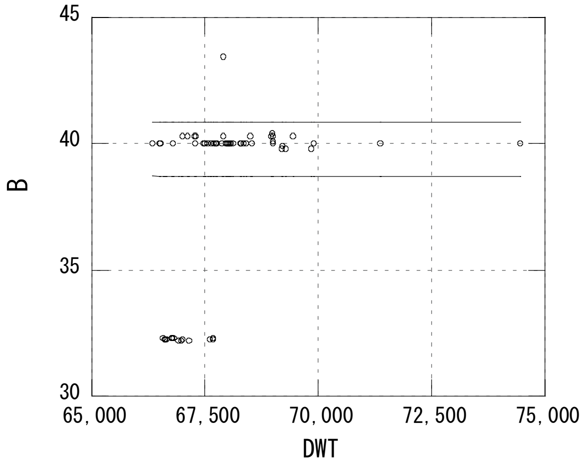
Figure 3-29 Container Ship
（45,000～Less than 55,000DWT）B-DWT



$Y=a_0$
(σ= 2.926)

	Average	75%
a_0	34.0	35.9

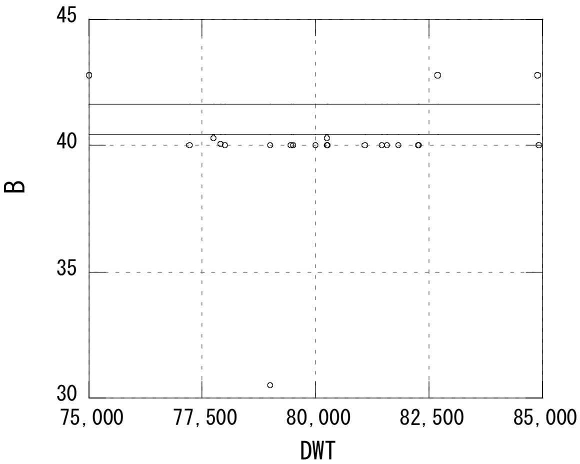
Figure 3-30 Container Ship
(55,000～Less than 65,000DWT) B-DWT



$Y=a_0$
(σ= 3.193)

	Average	75%
a_0	38.7	40.9

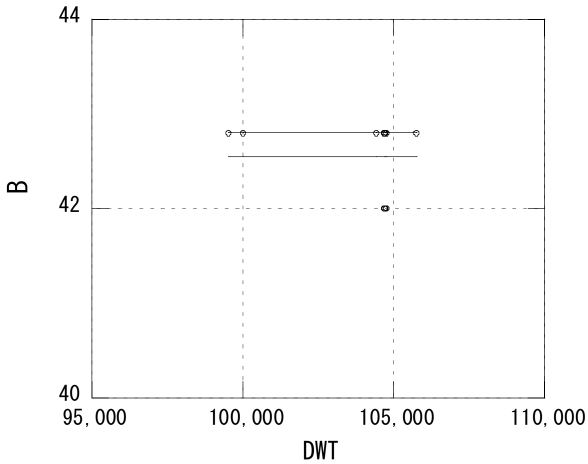
Figure 3-31 Container Ship
(65,000～Less than 75,000DWT) B-DWT



$Y=a_0$
(σ= 1.761)

	Average	75%
a_0	40.4	41.6

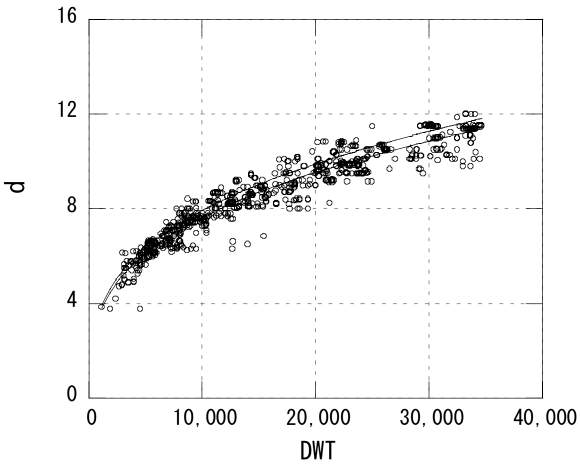
Figure 3-32 Container Ship
(75,000～Less than 85,000DWT) B-DWT

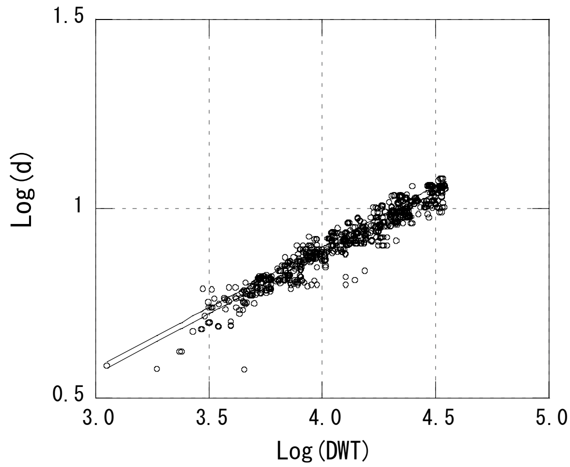


$Y=a_0$
(σ= 0.377)

	Average	75%
a_0	42.6	42.8

Figure 3-33 Container Ship
(95,000DWT～) B-DWT





$Y=\alpha \cdot X^{\beta}$

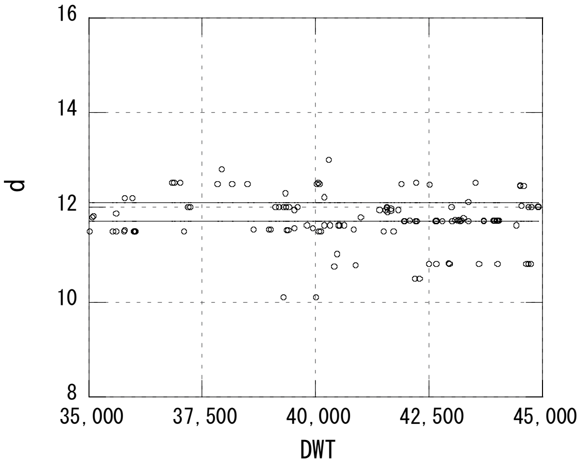
	50%	75%
α	0.3991	0.4143
β	0.3202	0.3202

$\log Y = a + b \log X$

(R^2= 0.930 , σ= 0.024)

	50%	75%
a	-0.3990	-0.3826
b	0.3202	0.3202

Figure 3-34 Container Ship（～Less than 35,000DWT）d-DWT



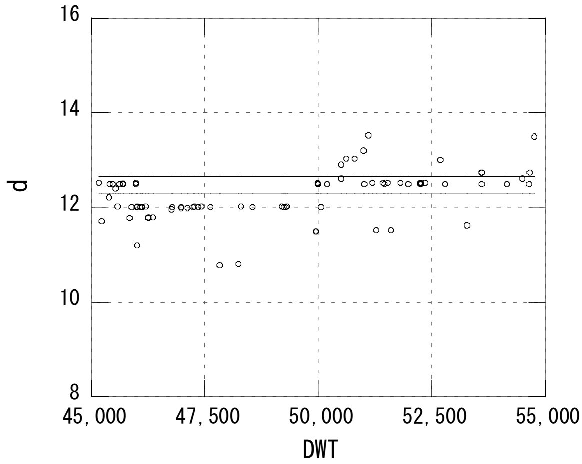
$Y=a_0$

（σ= 0.578 ）

	Average	75%
a_0	11.7	12.1

Figure 3-35 Container Ship

（35,000～Less than 45,000DWT）d-DWT



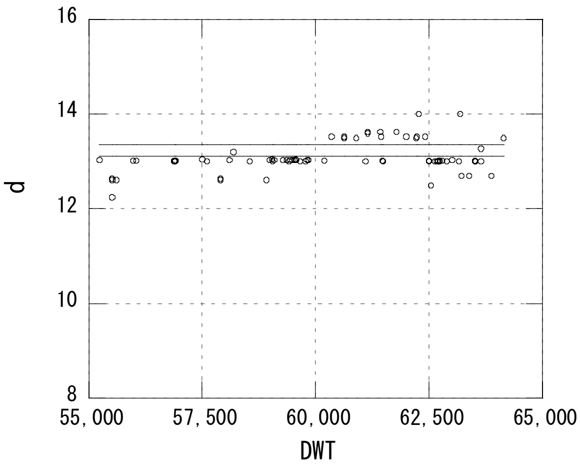
$Y=a_0$

（σ= 0.518 ）

	Average	75%
a_0	12.3	12.7

Figure 3-36 Container Ship

（45,000～Less than 55,000DWT）d-DWT

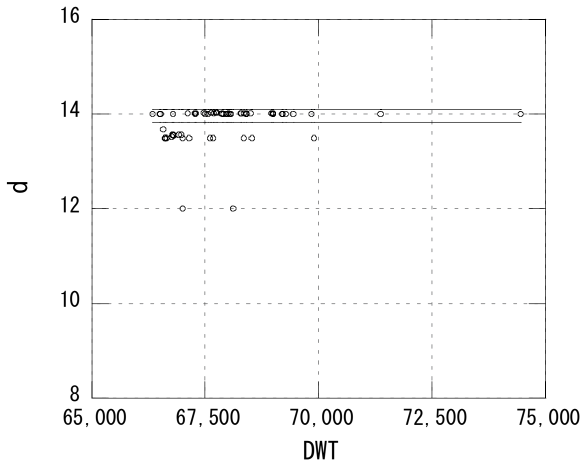


$Y=a_0$

(σ= 0.369)

	Average	75%
a_0	13.1	13.4

Figure 3-37 Container Ship
(55,000～Less than 65,000DWT) d-DWT

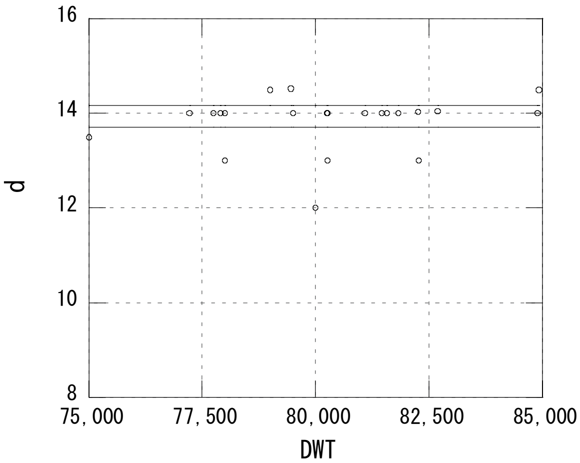


$Y=a_0$

(σ= 0.394)

	Average	75%
a_0	13.8	14.1

Figure 3-38 Container Ship
(65,000～Less than 75,000DWT) d-DWT

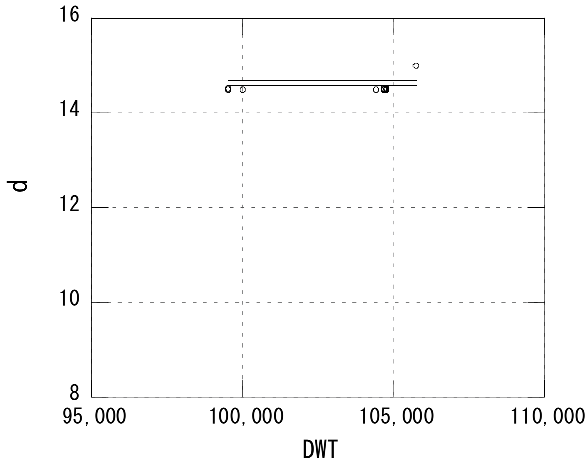


$Y=a_0$

(σ= 0.689)

	Average	75%
a_0	13.7	14.2

Figure 3-39 Container Ship
(75,000～Less than 85,000DWT) d-DWT



$Y=a_0$

(σ= 0.174)

	Average	75%
a_0	14.6	14.7

Figure 3-40 Container Ship
(95,000DWT～) d-DWT

(2) Analysis of container ships by type (Under-Panamax, Panamax, Over-Panamax)

In **Figure 3-10**, the B analysis diagram for DWT, B is a constant value of about 32m from approximately 30,000DWT regardless of the increase of DWT, and over 50,000DWT, it clearly rises discretely. This is caused by restrictions on overall width of ships passing through the Panama Canal. A ship shape with B that is the maximum overall width (32.3m) that can pass through the canal is called Panamax type. If B does not reach approximately 32m, it is called Under-Panamax type, and if it exceeds approximately 32m, it is called Over-Panamax type. Therefore with B = 32 m as the threshold, they are analyzed in three types: Under-Panamax, Panamax, and Over-Panamax types.

1) Under-Panamax type (**Figure 3-41** to **Figure 3-44**)

All Loa, Lpp, B, and d were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.930 for Loa, R^2 = 0.932 for Lpp, R^2 = 0.918 for B, and R^2 = 0.915 for d. But for B, the results of the logarithmic regression analysis method were used only up to 30,000DWT, and the average value was used for 40,000DWT. This is because the results for 40,000DWT that was analyzed applying the logarithmic regression analysis method exceeded 32.3. **Table 3-3** shows the results of analysis of each main dimension according to the ship class that was set.

2) Panamax type

i) Loa, Lpp (**Figure 3-45** to **Figure 3-46**)

Both Loa and Lpp were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.818 for Loa and R^2 = 0.839 for Lpp.

ii) B (**Figure 3-47**)

B was analyzed by the average value analysis method.

iii) d (**Figure 3-48**

d was analyzed by the linear regression analysis method, obtaining R^2 = 0.645. **Table 3-4** shows the results of analysis of each main dimension according to the ship class that was set.

3) Over-Panamax type (**Figure 3-49** to **Figure 3-52**)

Loa, Lpp, B, and D, were analyzed by the average value analysis method, with the following classification set for ships of 55,00DWT and higher.

・55,000DWT or higher, less than 65,000DWT
・65,000DWT or higher, less than 75,000DWT
・75,000DWT or higher, less than 100,000DWT

Table 3-5 shows the results of analysis of each main dimension according to the ship class that was set.

And in the case of the Over-Panamax type, **Table 3-6** presents the one-fourth value (25% value) and the three-fourth value (75% value) when, instead of statistical analysis results, the dimension for each ship class are aligned in rising order.

4) Super-large Container Ship – 1 (100,000DWT or more)

Table 3-7 shows the specific main dimensions for super-large Container Ship (100,000DWT or more) because the number of this class is limited.

5) Super-large Container Ship – 2 (8,000TEU or more)

Table 3-8 shows the specific main dimensions for super-large Container Ship (8,000TEU or more) because the number of this class is limited.

Table 3-3 The results of analysis of main dimensions (Under-Panamax)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)	Reference：the number of containers that can be loaded (TEU)
5,000	109	101	17.9	6.3	300 ～ 500
10,000	139	129	22.0	7.9	630 ～ 850
20,000	177	165	27.0	10.0	1,300 ～ 1,500
30,000	203	191	30.4	11.4	2,000 ～ 2,200
40,000	225	211	30.6	12.5	2,600 ～ 2,900

Table 3-4 The results of analysis of main dimensions (Panamax)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)	Reference：the number of containers that can be loaded (TEU)
30,000	201	187	32.3	11.3	2,100 ～ 2,400
40,000	237	223	32.3	12.0	2,800 ～ 3,200
50,000	270	255	32.3	12.7	3,400 ～ 3,900
60,000	300	285	32.3	13.4	4,000 ～ 4,600

Table 3-5 The results of analysis of main dimensions (Over-Panamax)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
60,000	285	268	40.0	13.8
70,000	280	266	40.0	14.0
85,000	304	292	42.8	14.5

Table 3-6 The results of analysis of main dimensions (Over Panamax) 25%/75%

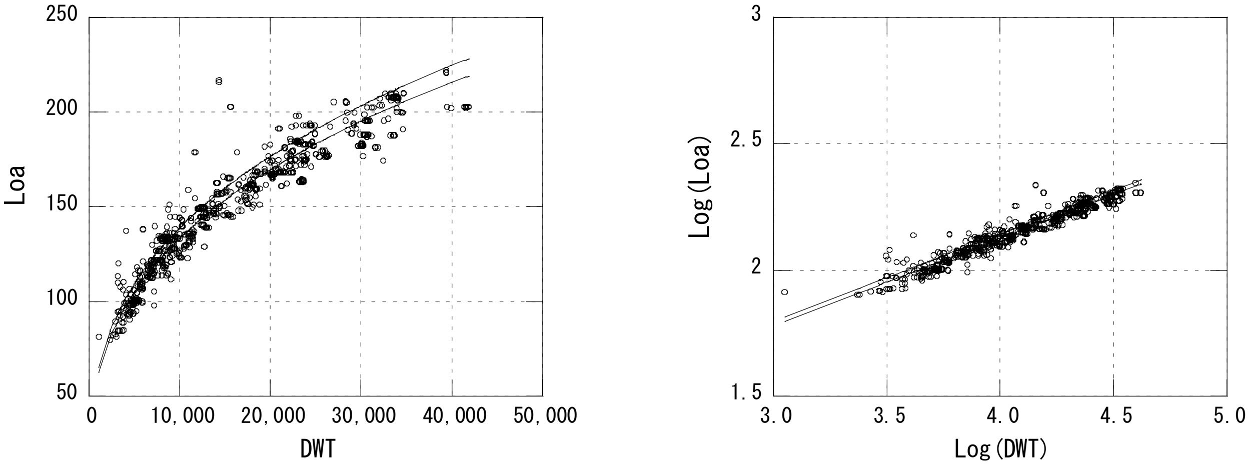
Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)	Reference：the number of containers that can be loaded (TEU)
60,000	275／285	260／268	37.2／40.0	12.7／13.8	4,300 ～ 5,400
70,000	276／280	263／266	40.0／40.0	14.0／14.0	5,300 ～ 5,600
80,000～100,000	300／304	285／292	40.0／42.8	13.5／14.5	6,300 ～ 6,700

Table 3-7 The super-large container ships (100,000DWT or more)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)	Reference：the number of containers that can be loaded (TEU)
100,019	320	―	42.8	14.5	7,179
104,690	347	332	42.8	14.5	7,226
104,696	347	332	42.0	14.5	7,226
104,700	347	332	42.0	14.5	7,226
104,750	347	332	42.8	14.5	7,226
104,750	353	336	42.8	15.0	7,900

Table 3-8 The super-large container ships (80,000TEU or more)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)	Reference : the number of containers that can be loaded (TEU)
99,518	323	308	42.8	14.5	8,063
101,898	334	―	42.8	14.5	8,238
97,517	335	―	42.8	14.0	8,450
101,612	334	―	42.8	14.5	8,468



$Y=\alpha \cdot X^{\beta}$

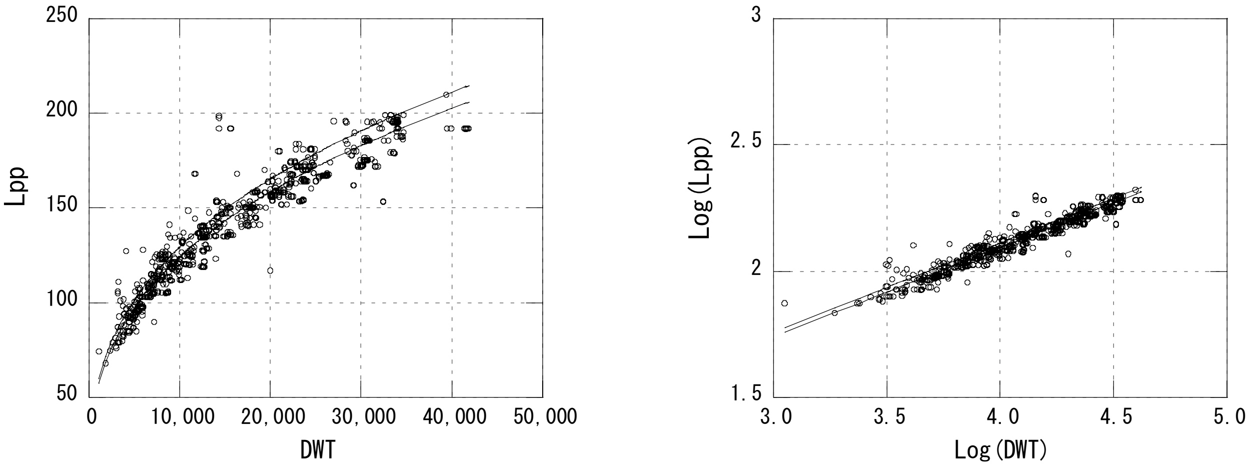
	50%	75%
α	5.4713	5.6992
β	0.3467	0.3467

$\log Y = a + b \log X$

(R^2= 0.930 , σ= 0.026)

	50%	75%
a	0.7381	0.7558
b	0.3467	0.3467

Figure 3-41 Container Ship (Under-Panamax)Loa-DWT



$Y=\alpha \cdot X^{\beta}$

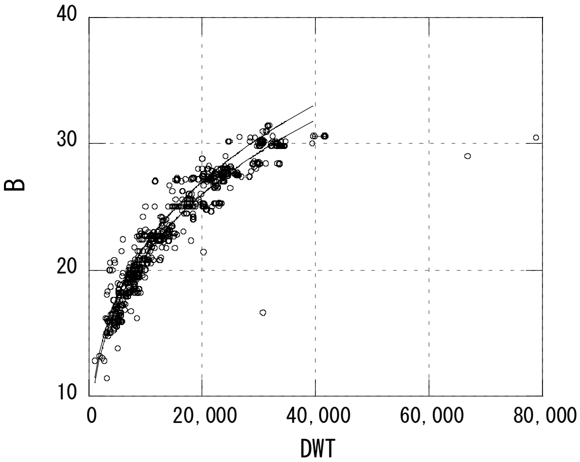
	50%	75%
α	4.7889	4.9920
β	0.3534	0.3534

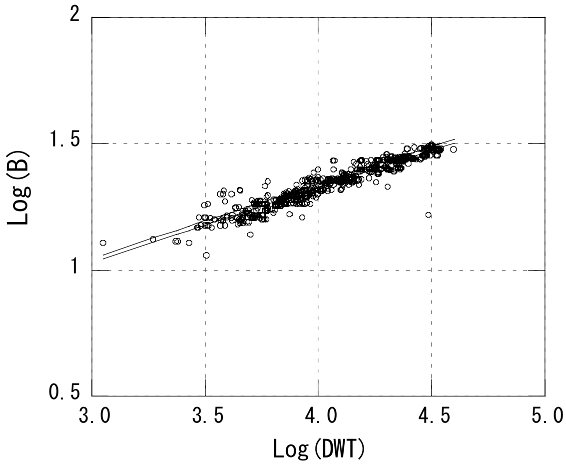
$\log Y = a + b \log X$

(R^2= 0.932 , σ= 0.027)

	50%	75%
a	0.6802	0.6983
b	0.3534	0.3534

Figure 3-42 Container Ship （Under-Panamax)Lpp-DWT





・Less than 40,000DWT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	1.3858	1.4393
β	0.2960	0.2960

・40,000DWT～

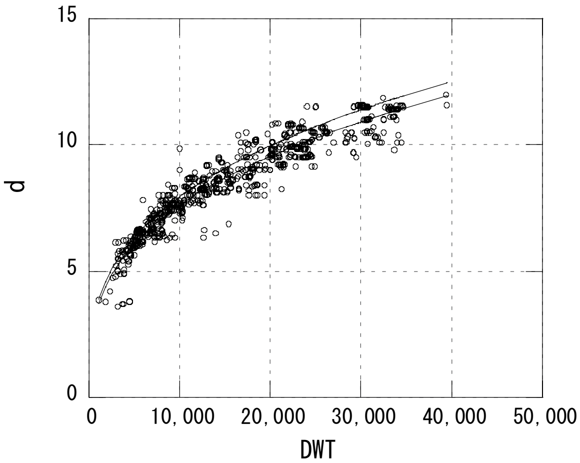
Y＝30.6

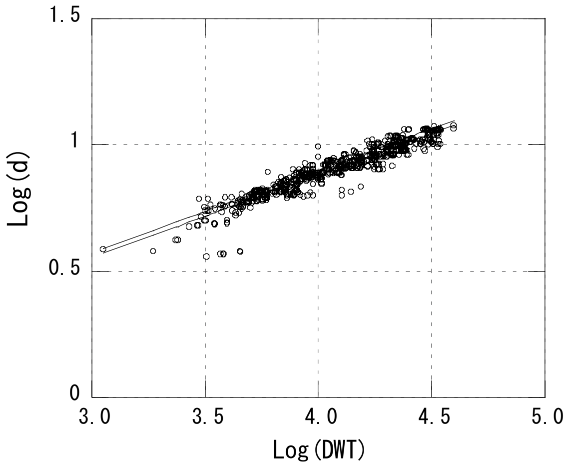
logY=a+blogX

(R^2= 0.918 , σ= 0.024)

	50%	75%
a	0.1417	0.1582
b	0.2960	0.2960

Figure 3-43 Container Ship（Under-Panamax)B-DWT





$Y=\alpha \cdot X^{\beta}$

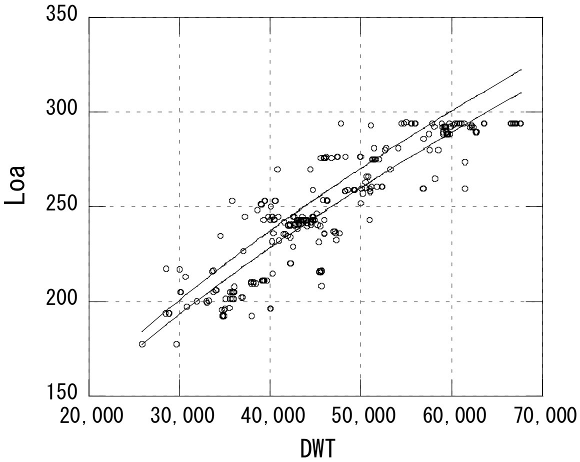
	50%	75%
α	0.3719	0.3882
β	0.3277	0.3277

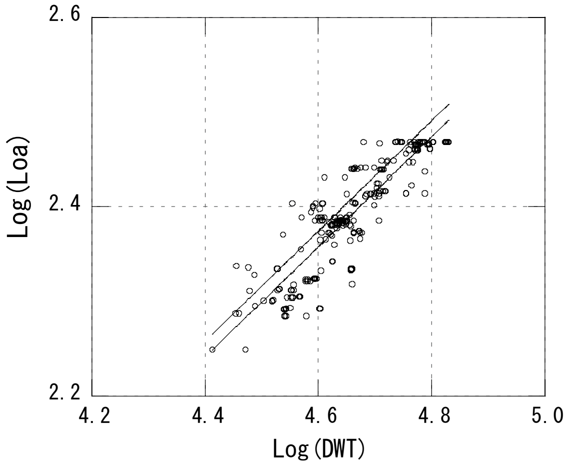
logY=a+blogX

(R^2= 0.915 , σ= 0.028)

	50%	75%
a	-0.4296	-0.4109
b	0.3277	0.3277

Figure 3-44 Container Ship (Under-Panamax)d-DWT





$Y=\alpha \cdot X^{\beta}$

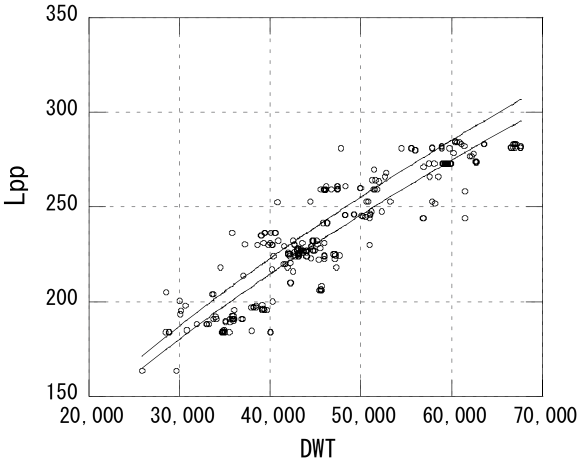
	50%	75%
α	0.4772	0.4959
β	0.5824	0.5824

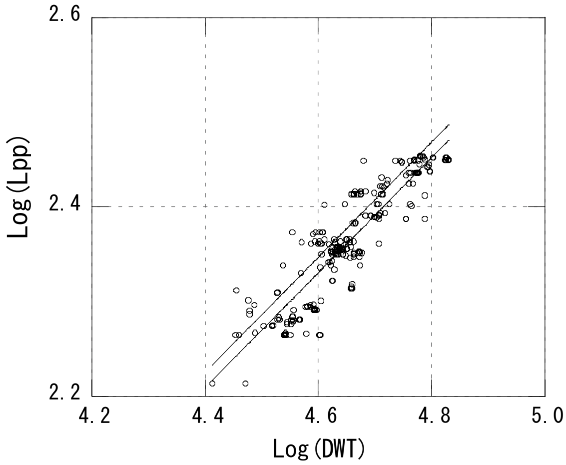
logY=a+blogX

(R^2= 0.818 , σ= 0.025)

	50%	75%
a	-0.3213	-0.3046
b	0.5824	0.5824

Figure 3-45 Container Ship (Panamax)Loa-DWT





$Y=\alpha \cdot X^{\beta}$

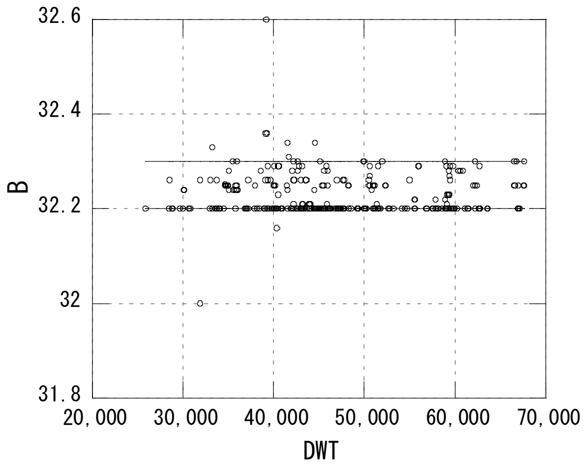
	50%	75%
α	0.3411	0.3542
β	0.6082	0.6082

logY=a+blogX

(R^2= 0.839 , σ= 0.024)

	50%	75%
a	-0.4671	-0.4507
b	0.6082	0.6082

Figure 3-46 Container Ship (Panamax)Lpp-DWT

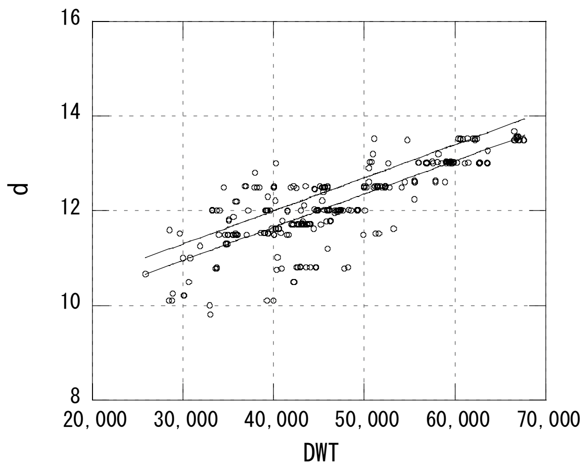


$Y=a_0$

（$\sigma=$ 0.039 ）

	Average	75%
a_0	32.2	32.3

Figure 3-47 Container Ship (Panamax)B-DWT



$Y=a_0+b_0X$

($R^2=$ 0.645 , $\sigma=$ 0.510 ）

	50%	75%
a_0	8.8539	9.1978
b_0	0.000070	0.000070

Figure 3-48 Container Ship（Panamax)d-DWT

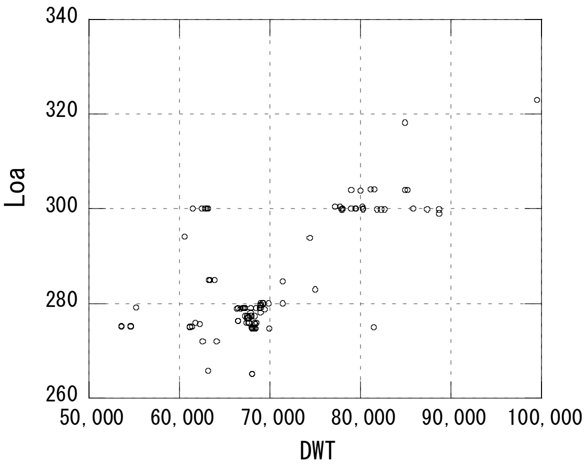


Figure 3-49 Container Ship(Over-Panamax)
Loa-DWT

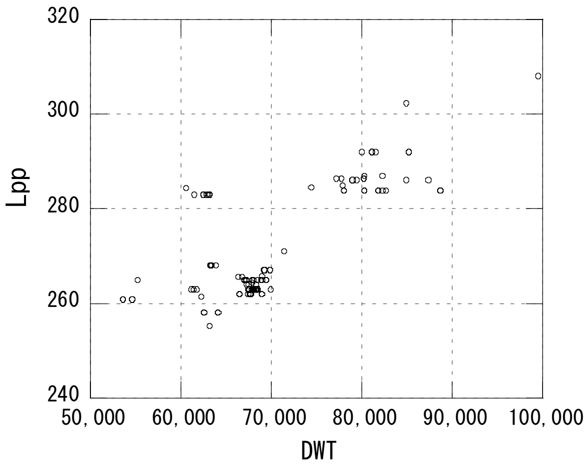


Figure 3-50 Container Ship (Over-Panamax)
Lpp-DWT

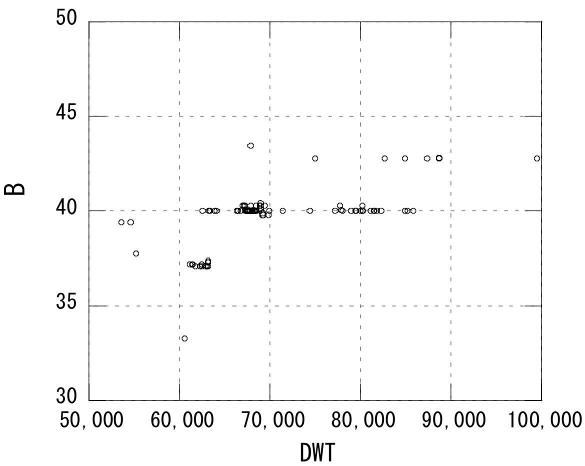


Figure 3-51 Container Ship (Over-Panamax)
B-DWT

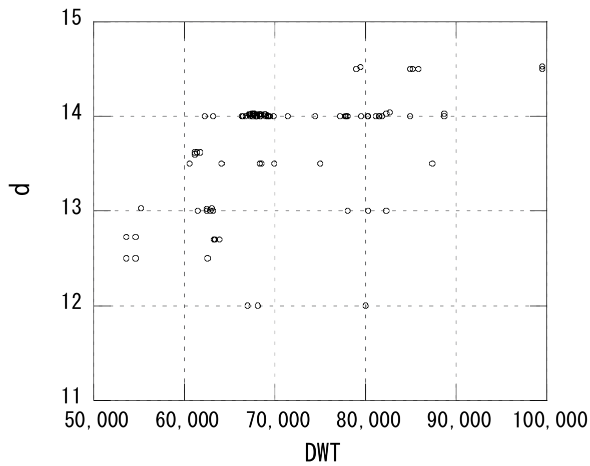


Figure 3-52 Container Ship (Over-Panamax)
d-DWT

(3) Analysis of TEU

1) Integrated analysis of all ships (**Figure 3-53**)

TEU was analyzed by the linear regression analysis method, obtaining R^2 = 0.974.

2) Under-Panamax type（**Figure 3-54**）

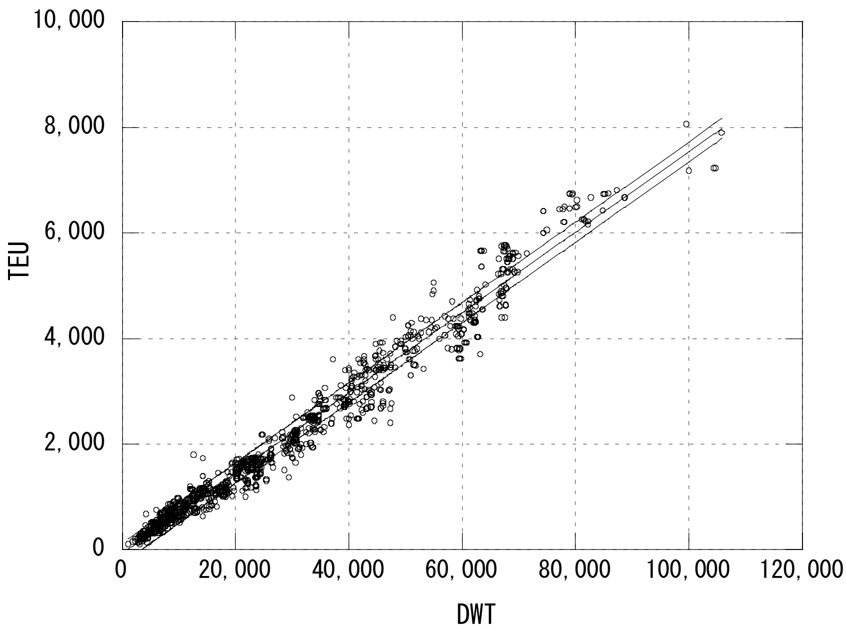
TEU was analyzed by the linear regression analysis method, obtaining R^2 = 0.939.

3) Panamax type (**Figure 3-55**)

TEU was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.786.

4) Over-Panamax type (**Figure 3-56**)

TEU was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.825.



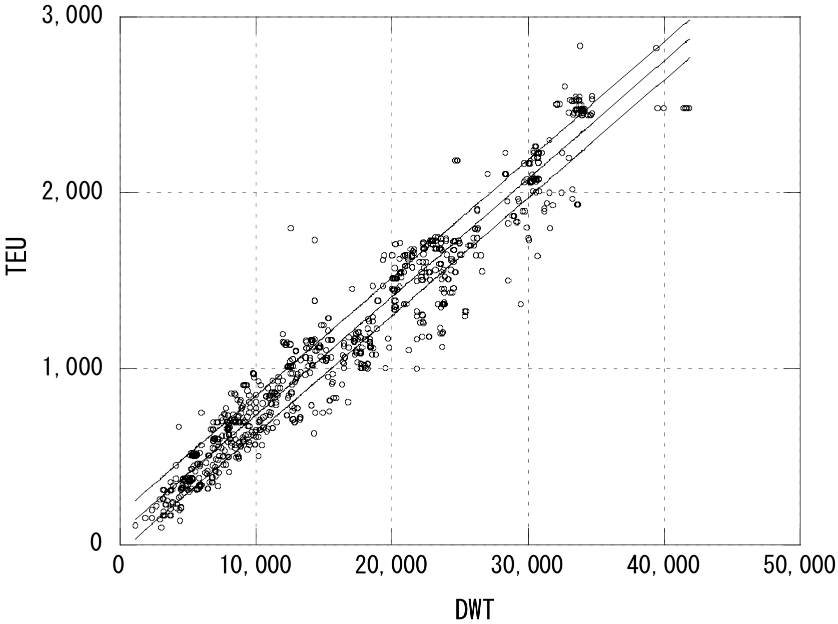
$$Y=a_0+b_0X$$

(R^2= 0.974 , σ= 283.065)

	25%	50%	75%
a_0	-260.0735	-69.2877	121.4981
b_0	0.0760	0.0760	0.0760

DWT	TEU		
	25%	50%	75%
5,000	119.9	310.7	501.5
10,000	499.9	690.7	881.5
20,000	1259.9	1450.7	1641.5
30,000	2019.9	2210.7	2401.5
40,000	2779.9	2970.7	3161.5
50,000	3539.9	3730.7	3921.5
60,000	4299.9	4490.7	4681.5
70,000	5059.9	5250.7	5441.5
80,000	5819.9	6010.7	6201.5
90,000	6579.9	6770.7	6961.5
100,000	7339.9	7530.7	7721.5

Figure 3-53 Container Ship TEU-DWT



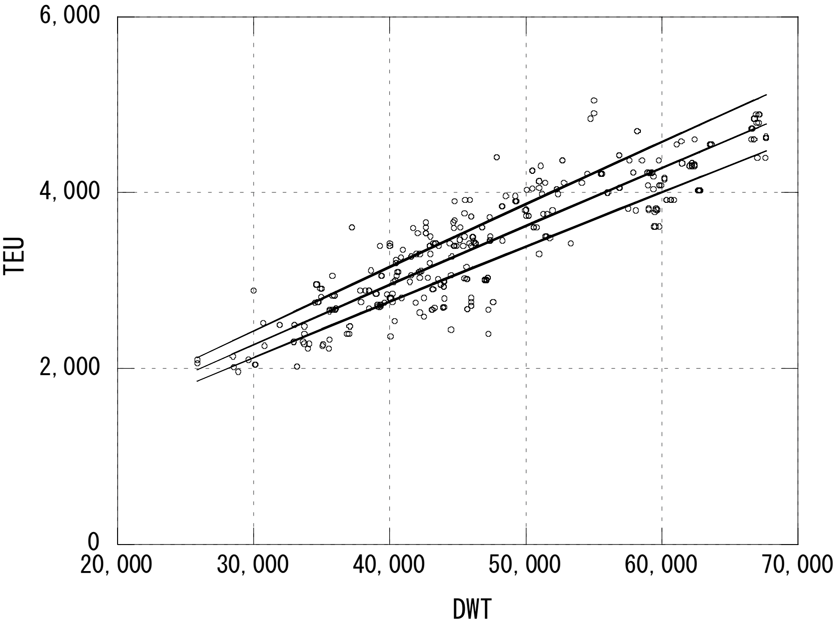
$$Y=a_0+b_0X$$

(R^2= 0.939 , σ= 160.274)

	25%	50%	75%
a_0	-39.2625	68.7622	176.7870
b_0	0.0670	0.0670	0.0670

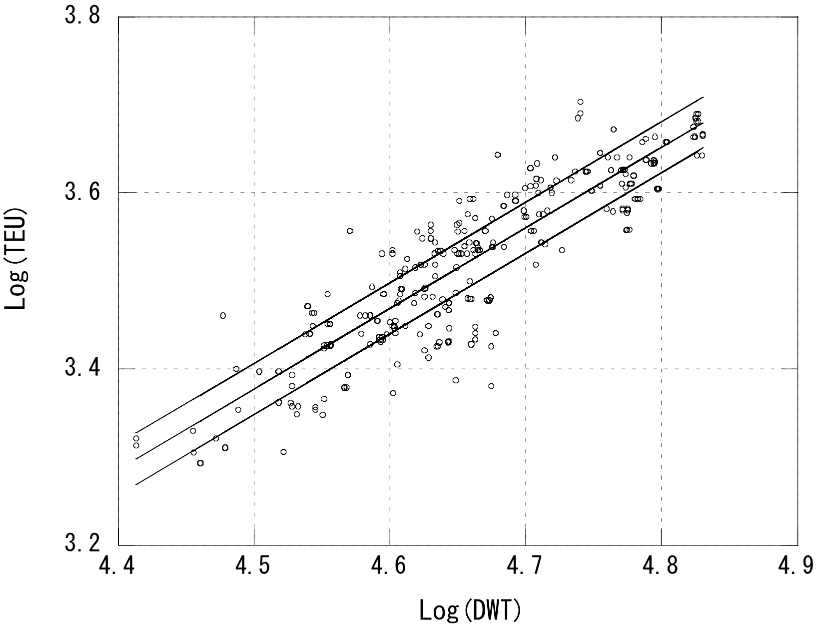
DWT	TEU 25%	50%	75%
5,000	296	404	512
10,000	631	739	847
20,000	1302	1410	1518
30,000	1972	2080	2188
40,000	2642	2750	2858

Figure 3-54 Container Ship (Under-Panamax) TEU-DWT



$Y=\alpha \cdot X^{\beta}$

	50%	75%	25%
α	0.1820	0.1946	0.1703
β	0.9150	0.9150	0.9150



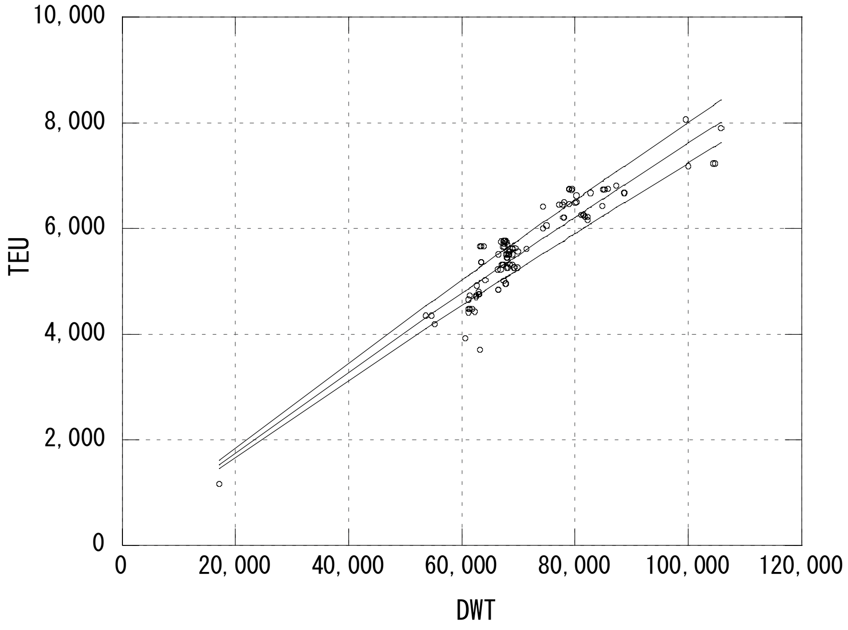
logY=a+blogX

(R^2= 0.786 , σ= 0.043)

	50%	75%	25%
a	-0.7399	-0.7109	-0.7689
b	0.9150	0.9150	0.9150

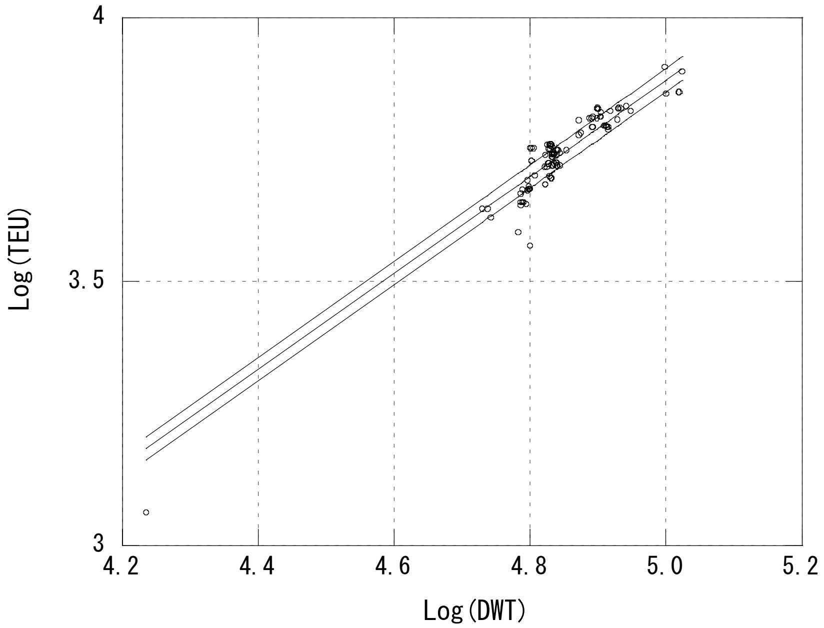
DWT	TEU		
	25%	50%	75%
30,000	2127	2273	2431
40,000	2768	2958	3162
50,000	3394	3628	3879
60,000	4011	4286	4583

Figure 3-55 Container Ship (Panamax) TEU-DWT



$Y=\alpha \cdot X^{\beta}$

	50%	75%	25%
α	0.2070	0.2178	0.1968
β	0.9131	0.9131	0.9131



logY=a+blogX

(R^2= 0.825 , σ= 0.033)

	50%	75%	25%
a	-0.6840	-0.6620	-0.7060
b	0.9131	0.9131	0.9131

DWT	TEU		
	25%	50%	75%
60,000	4539	4774	5023
70,000	5225	5496	5783
80,000	5903	6208	6532
100,000	7236	7612	8009

Figure 3-56 Container Ship (Over-Panamax) TEU-DWT

3.3 Oil Tanker

Figure 3-57 to **Figure 3-59** show the results of analysis of Loa, B, and d for DWT. And the following are the analysis method applied to each main dimension and the range of the ship classes to which each method was applied. And **Table 3-9** shows the results of analysis of the main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-60** to **Figure 3-65**)
The ships were divided into three classes with 8,000DWT and 200,000DWT as the boundaries. Less than 8,000DWT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.855 for Loa and R^2 = 0.938 for Lpp. 8,000DWT or more and less than 200,000DWT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.871 for Loa and R^2 = 0.915 for Lpp. 200,000DWT or more and less than 400,000DWT was analyzed by the average value analysis method.

(2) B (**Figure 3-66** to **Figure 3-68**)
The ships were divided into three classes with 8,000DWT and 200,000DWT as the boundaries. Less than 8,000DWT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.695. 8,000DWT or more and less than 200,000DWT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.807. 200,000DWT or more and less than 400,000DWT was analyzed by the average value analysis method.

(3) d (**Figure 3-69**, **70**)
The ship were divided into two classes with 50,000DWT as the boundary and the logarithmic regression analysis method was applied to each class, obtaining R^2 = 0.830 for less than 50,000DWT and R^2 = 0.870 for 50,000DWT or more.

Table 3-9 The results of analysis of main dimensions (Oil Tanker)

Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
1,000	63	57	11.0	4.0
2,000	77	72	13.2	4.9
3,000	86	82	14.7	5.5
5,000	100	97	16.7	6.4
10,000	139	131	20.6	7.6
15,000	154	146	23.4	8.6
20,000	166	157	25.6	9.3
30,000	184	175	29.1	10.4
50,000	209	199	34.3	12.0
70,000	228	217	38.1	12.9
90,000	243	232	41.3	14.2
100,000	250	238	42.7	14.8
150,000	277	265	48.6	17.2
300,000	334	321	59.4	22.4

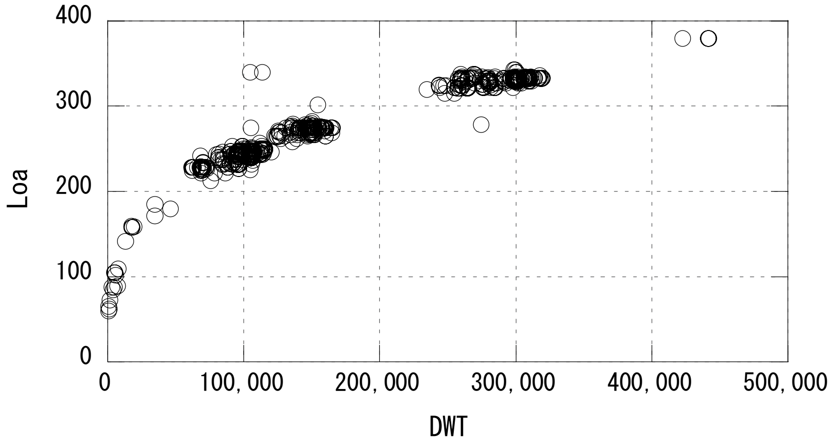


Figure 3-57 Oil Tanker Loa-DWT

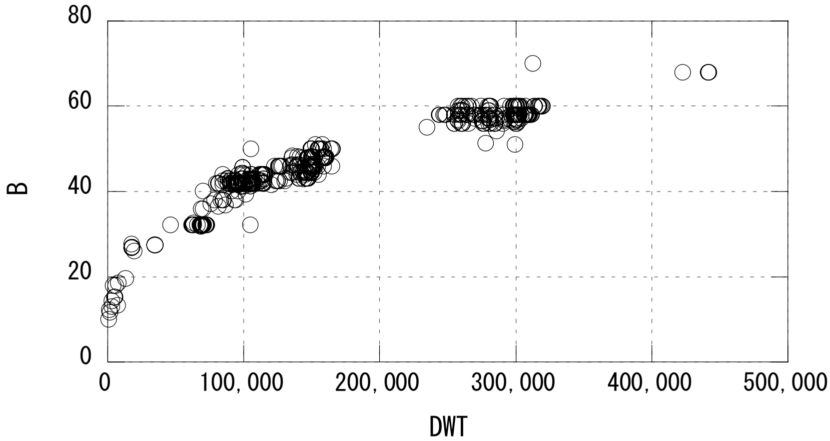


Figure 3-58 Oil Tanker B-DWT

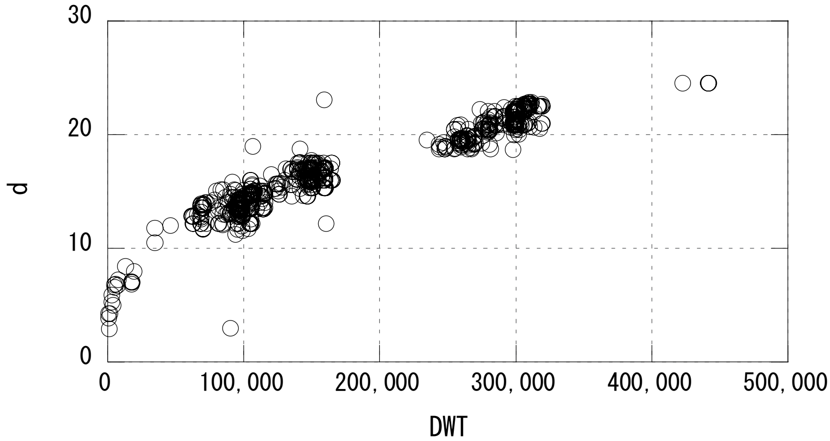
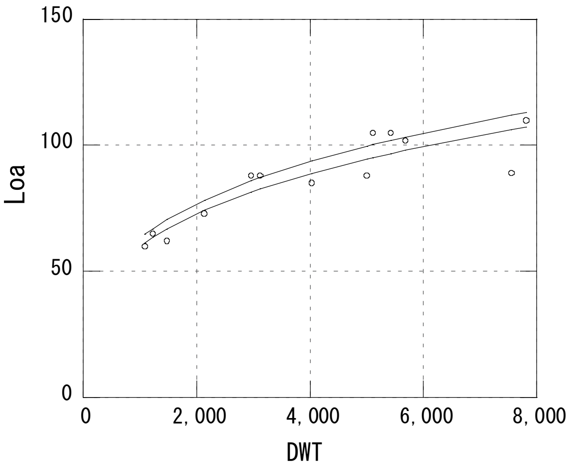
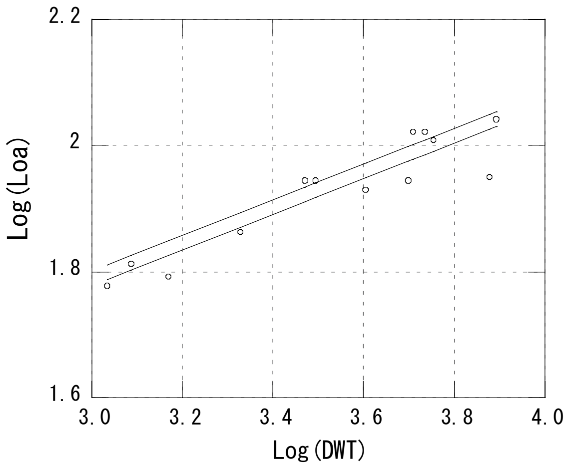


Figure 3-59 Oil Tanker d-DWT





$Y=\alpha \cdot X^{\beta}$

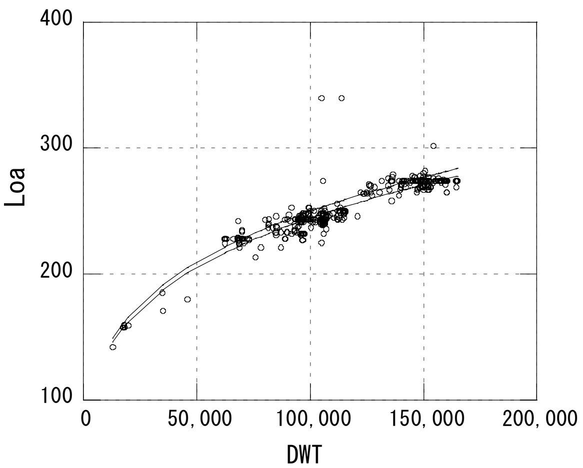
	50%	75%
α	8.5137	8.9769
β	0.2826	0.2826

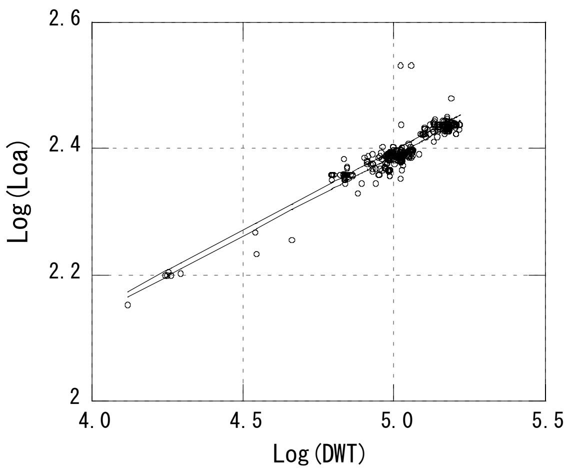
logY=a+blogX

(R^2= 0.855 , σ= 0.034)

	50%	75%
a	0.9301	0.9531
b	0.2826	0.2826

Figure 3-60 Oil Tanker (Less than 8,000DWT) Loa-DWT





$Y=\alpha \cdot X^{\beta}$

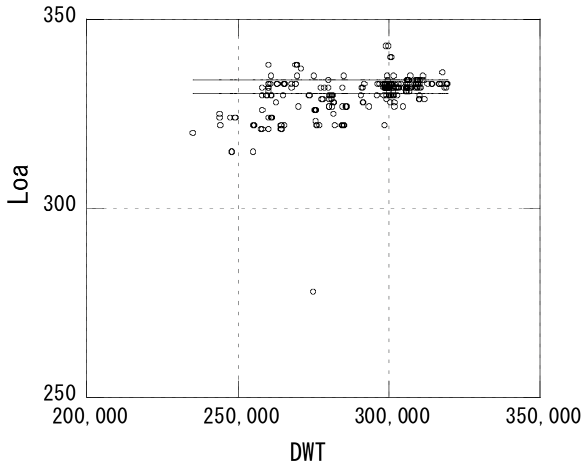
	50%	75%
α	13.1416	13.4278
β	0.2539	0.2539

logY=a+blogX

(R^2= 0.871 , σ= 0.014)

	50%	75%
a	1.1186	1.1280
b	0.2539	0.2539

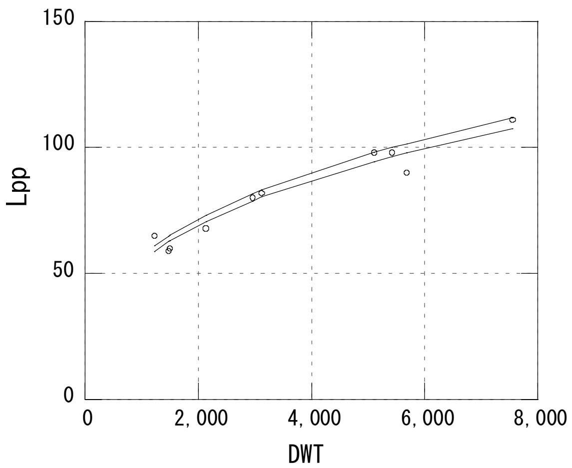
Figure 3-61 Oil Tanker (8,000～Less than 200,000DWT) Loa-DWT

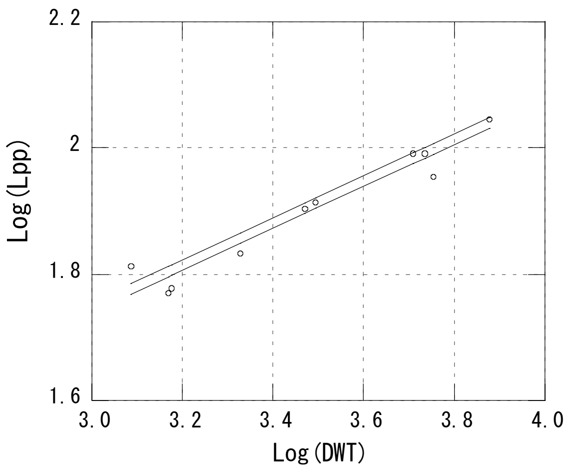


$Y=a_0$
(σ= 5.240)

	Average	75%
a_0	330.5	334.0

Figure 3-62 Oil Tanker (200,000～Less than 400,000DWT) Loa-DWT





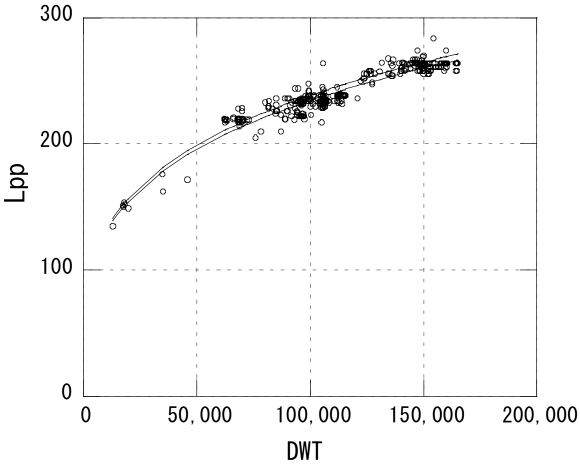
$Y=\alpha \cdot X^{\beta}$

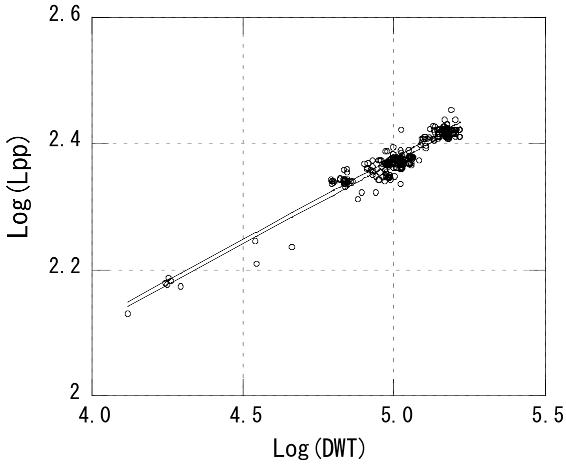
	50%	75%
α	5.5323	5.7430
β	0.3323	0.3323

logY=a+blogX
(R^2= 0.938 , σ= 0.024)

	50%	75%
a	0.7429	0.7591
b	0.3323	0.3323

Figure 3-63 Oil Tanker (Less than 8,000DWT) Lpp-DWT





$Y=\alpha \cdot X^{\beta}$

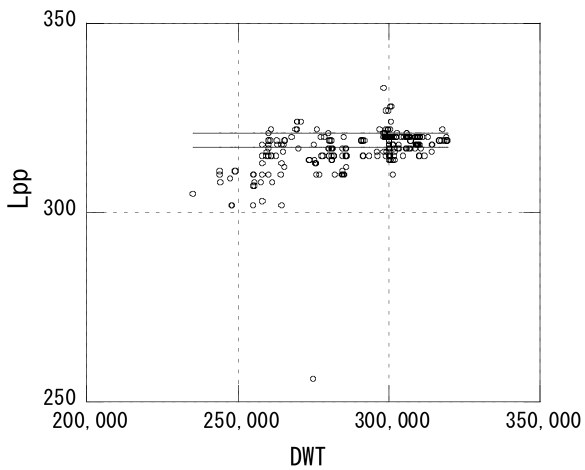
	50%	75%
α	11.9362	12.1401
β	0.2586	0.2586

$\log Y = a + b\log X$

($R^2 =$ 0.915 , $\sigma =$ 0.011)

	50%	75%
a	1.0769	1.0842
b	0.2586	0.2586

Figure 3-64 Oil Tanker (8,000～Less than 200,000DWT) Lpp-DWT

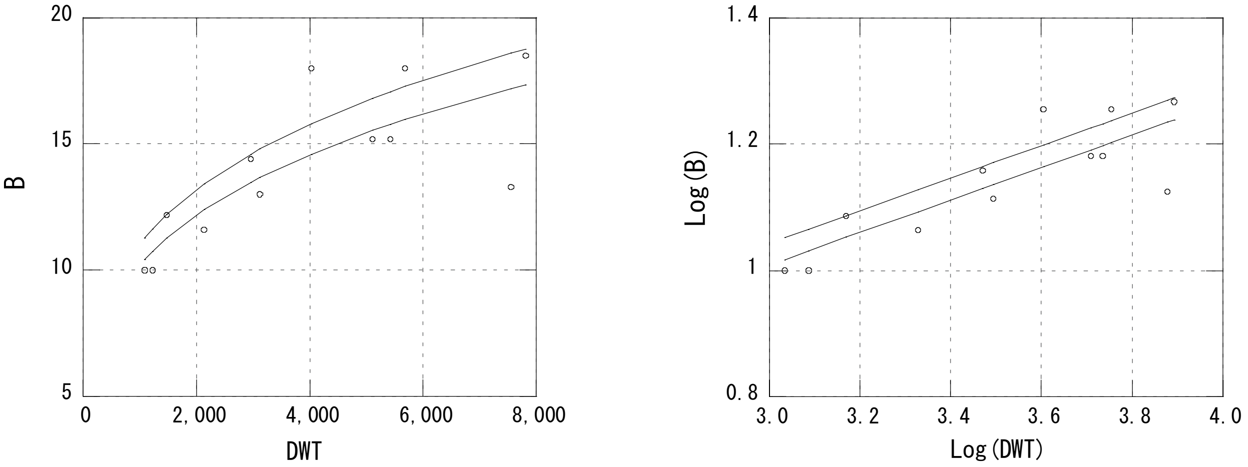


$Y=a_0$

($\sigma =$ 5.390)

	Average	75%
a_0	317.3	321.0

Figure 3-65 Oil Tanker (200,000～Less than 400,000DWT) Lpp-DWT



$Y=\alpha \cdot X^{\beta}$

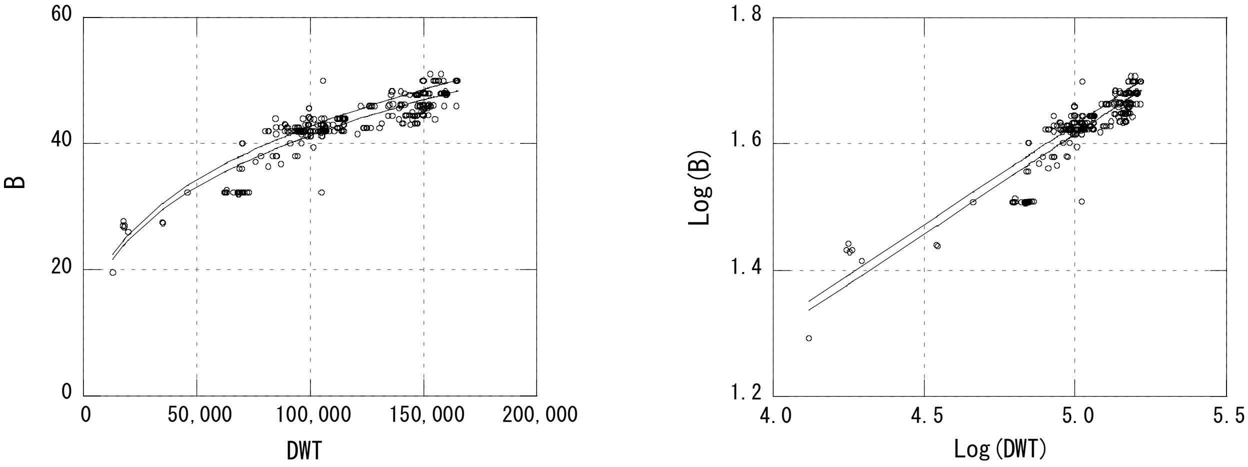
	50%	75%
α	1.7201	1.8629
β	0.2577	0.2577

$\log Y = a + b \log X$

(R^2= 0.695 , σ= 0.051)

	50%	75%
a	0.2356	0.2702
b	0.2577	0.2577

Figure 3-66 Oil Tanker (Less than 8,000DWT) B-DWT



$Y=\alpha \cdot X^{\beta}$

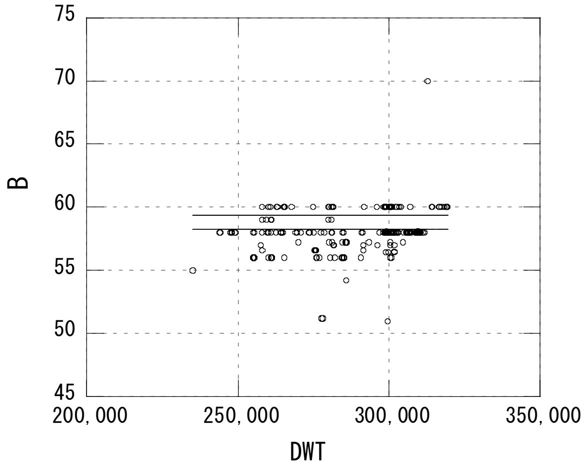
	50%	75%
α	1.0672	1.1043
β	0.3175	0.3175

$\log Y = a + b \log X$

(R^2= 0.807 , σ= 0.022)

	50%	75%
a	0.0282	0.0431
b	0.3175	0.3175

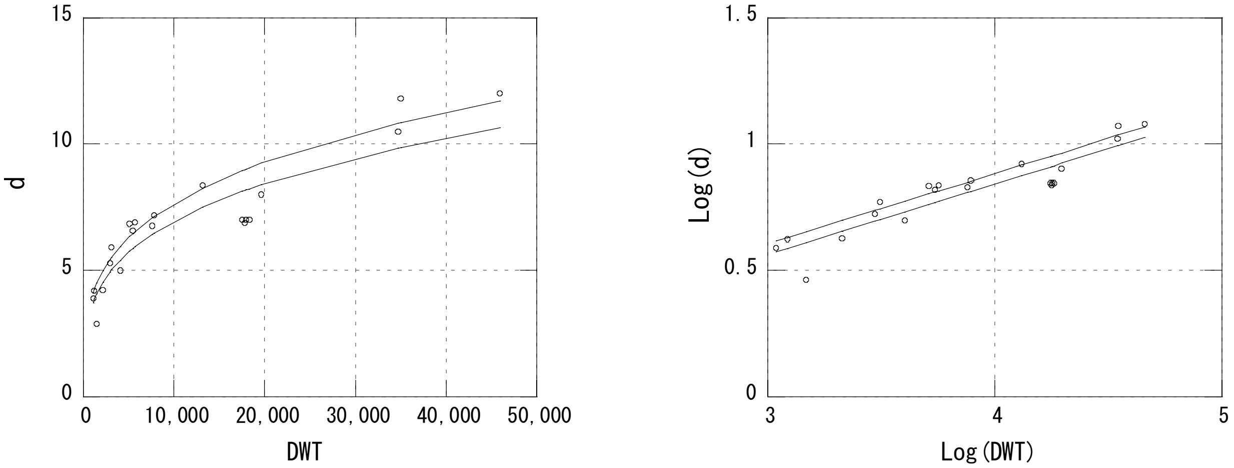
Figure 3-67 Oil Tanker (8,000～Less than 200,000DWT) B-DWT



$Y=a_0$
$(\sigma= 1.673)$

	Average	75%
a_0	58.2	59.4

Figure 3-68 Oil Tanker (200,000～Less than 400,000DWT) B-DWT



$Y=\alpha \cdot X^{\beta}$

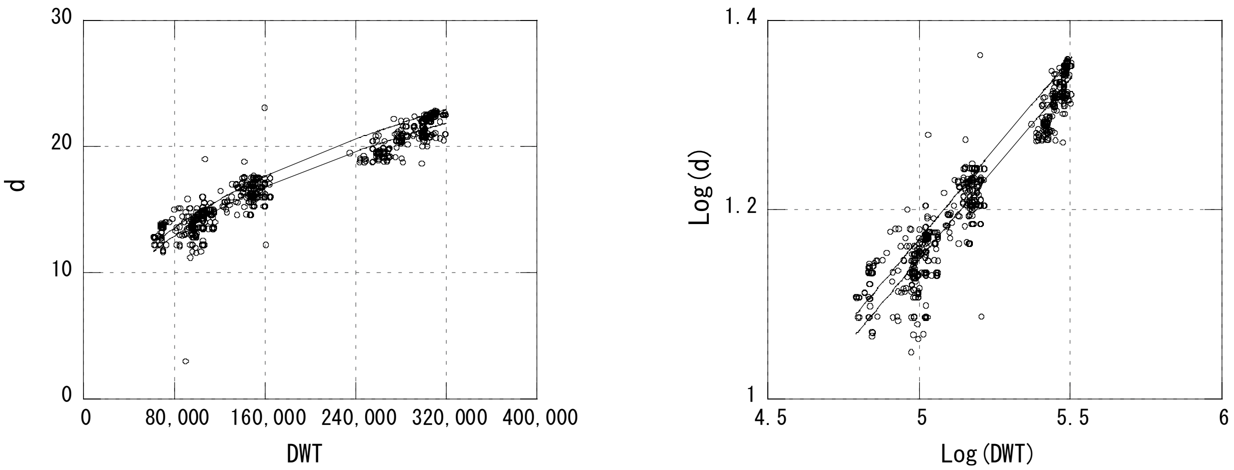
	50%	75%
α	0.5339	0.5877
β	0.2786	0.2786

logY=a+blogX

(R^2= 0.830 , σ= 0.062)

	50%	75%
a	-0.2725	-0.2309
b	0.2786	0.2786

Figure 3-69 Oil Tanker (～50,000DWT) d-DWT



$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.1748	0.1836
β	0.3810	0.3810

logY=a+blogX

(R^2= 0.870 , σ= 0.031)

	50%	75%
a	-0.7574	-0.7362
b	0.3810	0.3810

Figure 3-70 Oil Tanker (greater than 50,000～Less than 400,000DWT) d-DWT

3.4 Roll-on/Roll-off Ship

Figure 3-71 to **Figure 3-73** show the results of analysis of Loa, B, and d for GT. And the following are the analysis method applied to each main dimension and the range of the ship classes to which each method was applied. Because the dimensions of ships of 60,000GT or more are unique, they were exempted from the statistical analysis. **Table 3-10** shows the results of analysis of each main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-74**, **75**)

The ships were divided into three classes with 30,000GT and 40,000GT as the boundaries. Less than 30,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.906 for Loa and R^2 = 0.900 for Lpp. 30,000GT or more and less than 40,000GT and 40,000GT or more and less than 60,000GT were analyzed by the average value analysis method.

(2) B (**Figure 3-76**)

The ships were divided into two classes with 40,000GT as the boundary. Less than 40,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.725. 40,000GT or more and less than 60,000GT was analyzed by the average value analysis method.

(3) d (**Figure 3-77**)

The ships were divided into two classes with 30,000GT as the boundary. Less than 30,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.788. 30,000GT or more and less than 60,000GT was analyzed by the average value analysis method.

Table 3-10 The results of analysis of main dimensions(Roll-on/Roll-off Ship)

Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
3,000	98	88	18.1	4.6
5,000	117	105	20.4	5.5
10,000	149	136	23.9	6.9
20,000	189	174	28.0	8.7
40,000	194	174	32.3	9.7
60,000	208	189	32.3	9.7

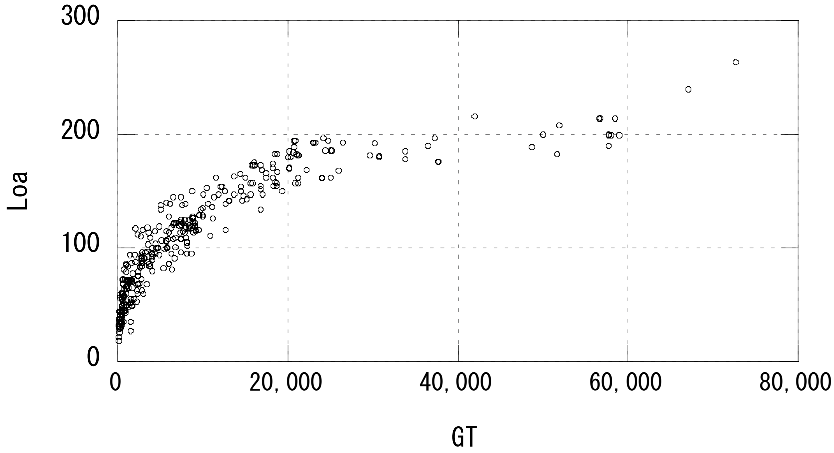


Figure 3-71 Roll-on/Roll-off Ship Loa-GT

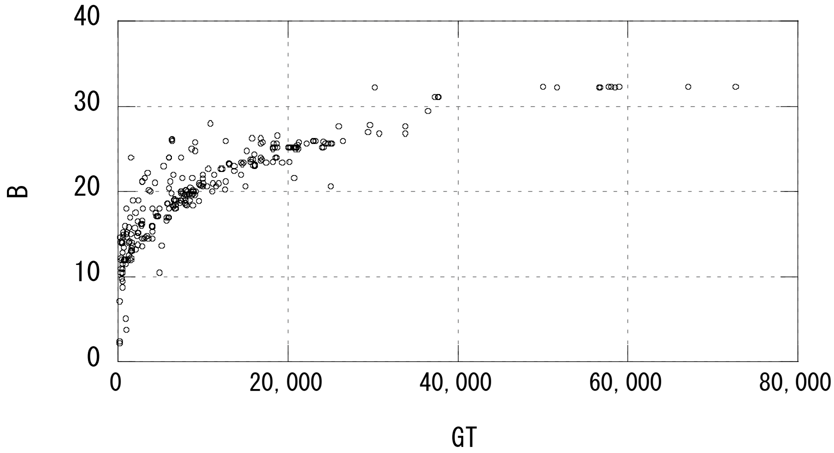


Figure 3-72 Roll-on/Roll-off Ship B-GT

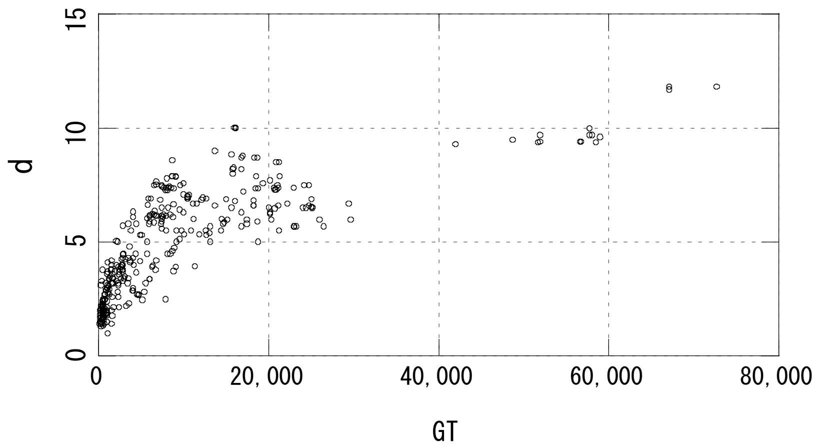
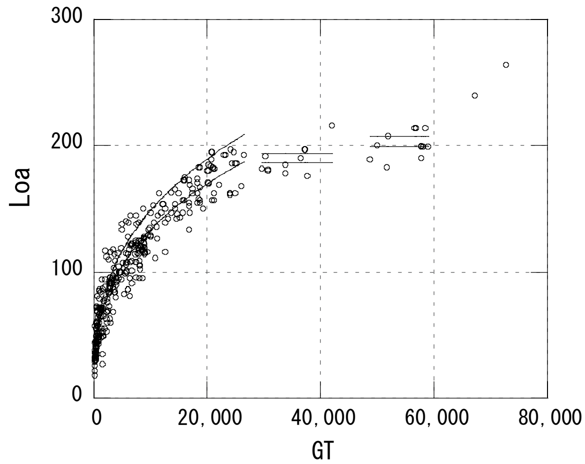
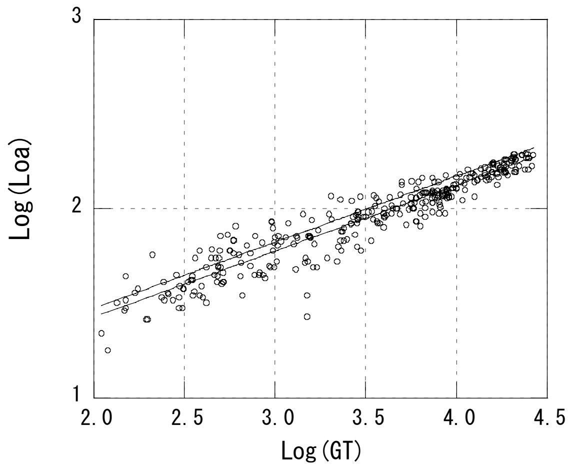


Figure 3-73 Roll-on/Roll-off Ship d-GT





・～Less than 30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	5.3729	5.9914
β	0.3487	0.3487

$\log Y = a + b \log X$

(R^2= 0.906 , σ= 0.070)

	50%	75%
a	0.7302	0.7775
b	0.3487	0.3487

・30,000GT～40,000GT

$Y=a_0$

（σ= 10.643 ）

	Average	75%
a_0	186.82	194.00

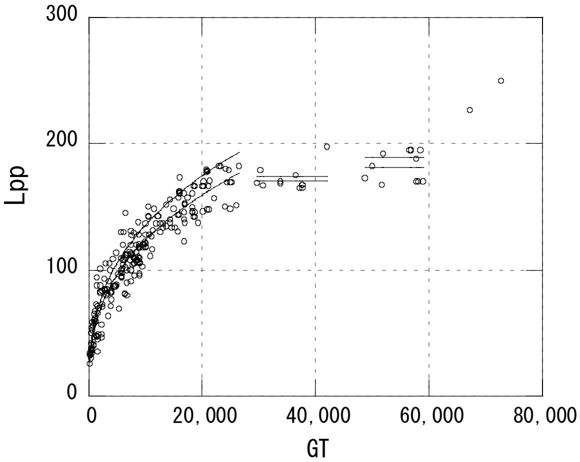
・Greater than 40,000GT～60,000GT

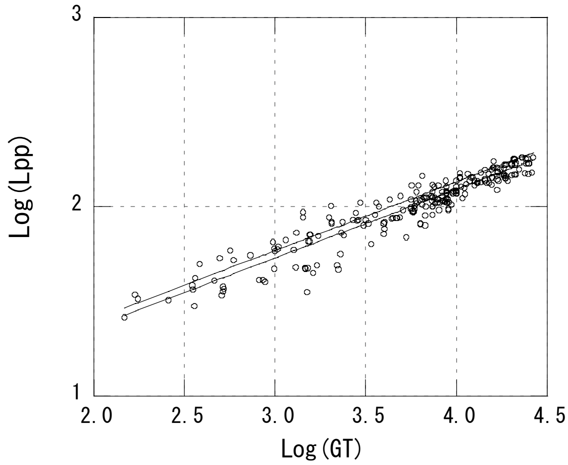
$Y=a_0$

（σ= 10.783 ）

	Average	75%
a_0	199.32	207.55

Figure 3-74 Roll-on/Roll-off Ship（～60,000GT）Loa-GT





・～Less than 30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	4.3514	4.7649
β	0.3636	0.3636

logY=a+blogX

(R^2= 0.900 , σ= 0.058)

	50%	75%
a	0.6386	0.6781
b	0.3636	0.3636

・30,000～40,000GT

$Y=a_0$

（σ= 4.918 ）

	Average	75%
a_0	170.47	173.79

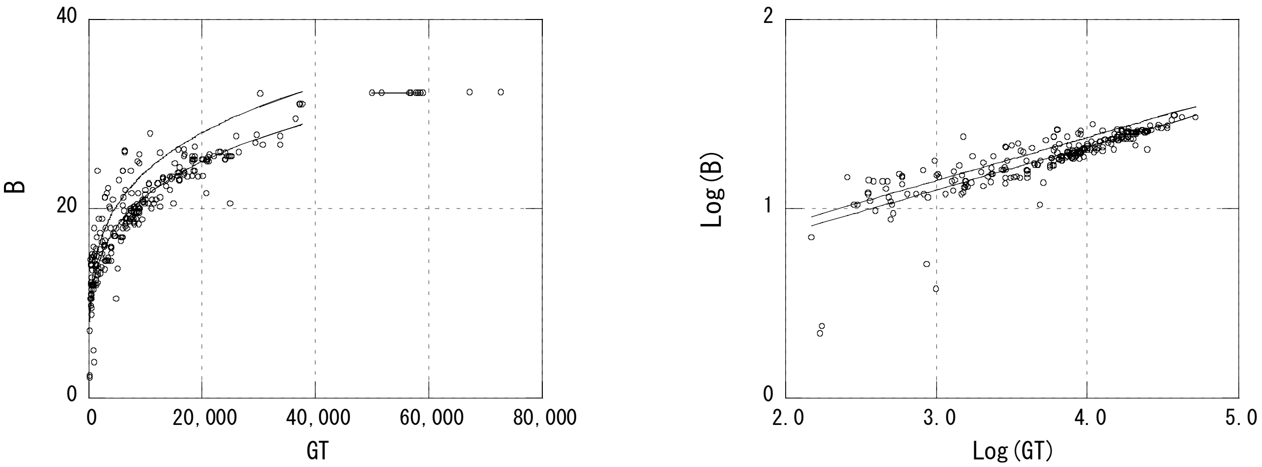
・Greater than 40,000～60,000GT

$Y=a_0$

（σ= 11.993 ）

	Average	75%
a_0	181.13	189.22

Figure 3-75 Roll-on/Roll-off Ship（～60,000GT） Lpp-GT



・〜Less than 40,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	2.5703	2.8814
β	0.2297	0.2297

・40,000GT〜60,000GT

$Y=a_0$

（σ=　0.005　）

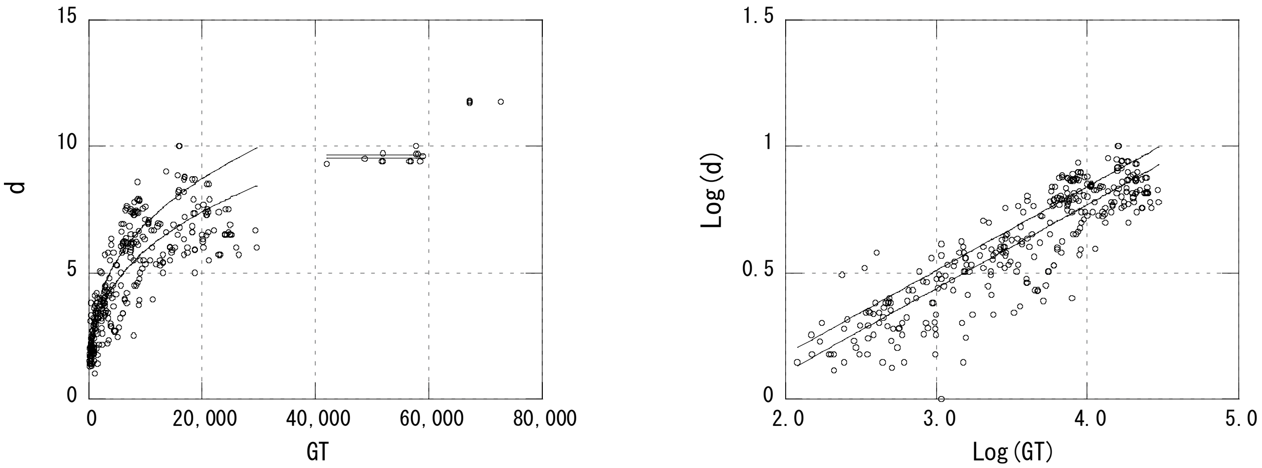
	Average	75%
a_0	32.26	32.26

$\log Y = a + b \log X$

（ R^2= 0.725 , σ= 0.074 ）

	50%	75%
a	0.4100	0.4596
b	0.2297	0.2297

Figure 3-76　Roll-on/Roll-off Ship (〜60,000GT)　B−GT



・〜Less than 30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.2775	0.3267
β	0.3316	0.3316

・30,000〜60,000GT

$Y=a_0$

（σ=　0.194　）

	Average	75%
a_0	9.5	9.7

$\log Y = a + b \log X$

（ R^2= 0.788 , σ= 0.105 ）

	50%	75%
a	-0.5568	-0.4859
b	0.3316	0.3316

Figure 3-77　Roll-on/Roll-off Ship（〜60,000GT）　d−GT

3.5 Pure Car Carrier(PCC)

Figure 3-78 to **Figure 3-80**show the results of analysis of Loa, B, and d for GT. And the following are the analysis method applied to each main dimension and the range of the ship classes to which each method was applied. **Table 3-11** shows the results of analysis of each main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-81**,**82**)

The ships were divided into three classes with 30,000GT and 50,000GT as the boundaries. Less than 30,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.775 for Loa and R^2 = 0.827 for Lpp. 30,000GT or more and less than 50,000GT and 50,000GT or more were analyzed by the average value analysis method.

(2) B (**Figure 3-83**)

The ships were divided into three classes with 30,000GT and 50,000GT as the boundaries. Less than 30,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.897. 30,000GT or more and less than 50,000GT and 50,000GT or more were analyzed by the average value analysis method.

(3) d (**Figure 3-84**)

The ships were divided into three classes with 30,000GT and 50,000GT as the boundaries. Less than 30,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.667. 30,000GT or more and less than 50,000GT and 50,000GT or more were analyzed by the average value analysis method.

Table 3-11 The results of analysis of main dimensions (Pure Car Carrier)

Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
3,000	89	72	16.1	4.7
5,000	104	88	18.0	5.4
12,000	135	123	21.8	6.8
20,000	158	150	24.4	7.9
30,000	179	175	26.7	8.8
40,000	185	175	31.9	9.3
60,000	203	194	32.3	10.4

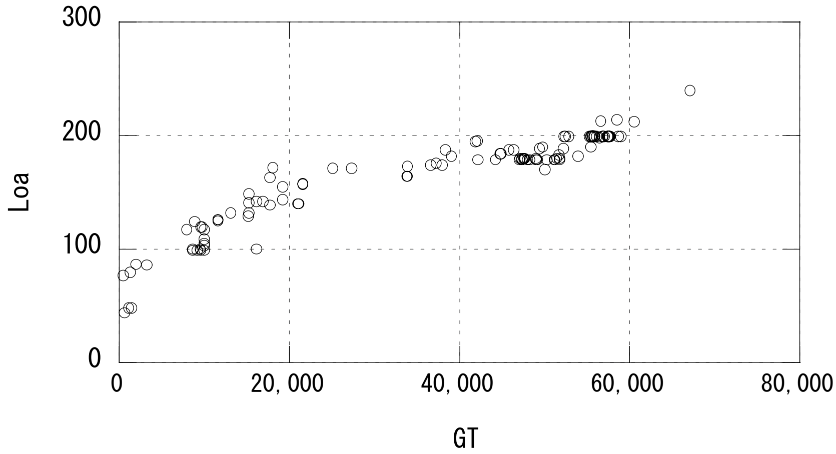


Figure 3-78 Pure Car Carrier Loa-GT

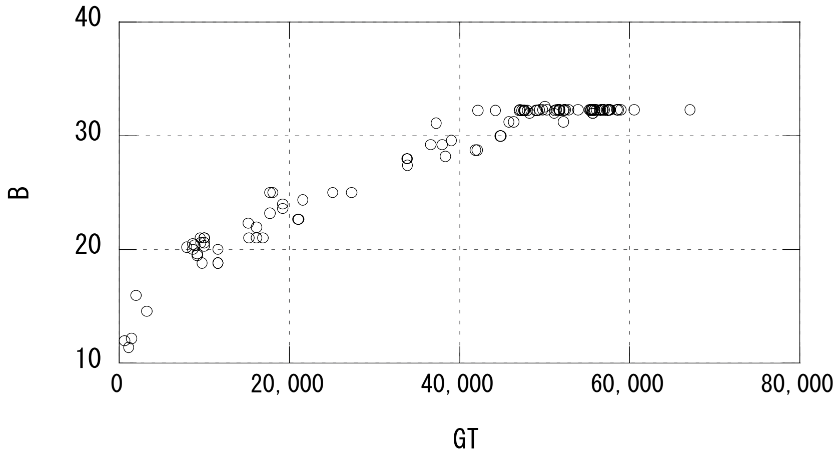


Figure 3-79 Pure Car Carrier B-GT

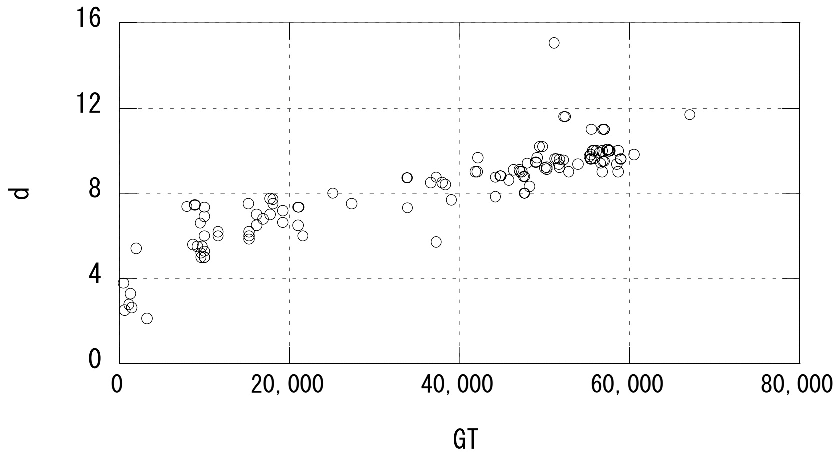
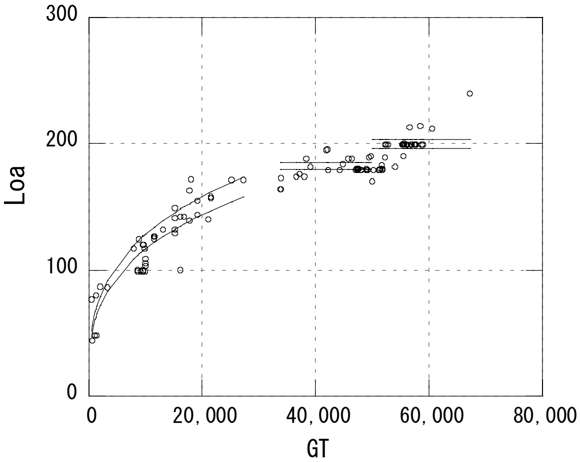
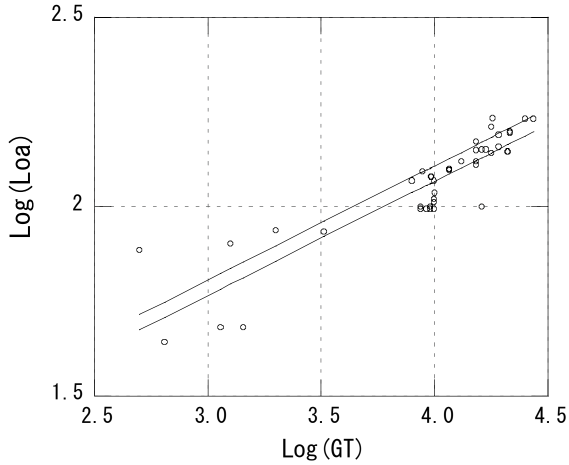


Figure 3-80 Pure Car Carrier d-GT





・～30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	7.2617	7.9846
β	0.3014	0.3014

$\log Y = a + b \log X$

(R^2= 0.775 , σ= 0.061)

	50%	75%
a	0.8610	0.9023
b	0.3014	0.3014

・Greater than 30,000～Less than 50,000GT

$Y=a_0$

(σ= 7.358)

	Average	75%
a_0	179.96	184.92

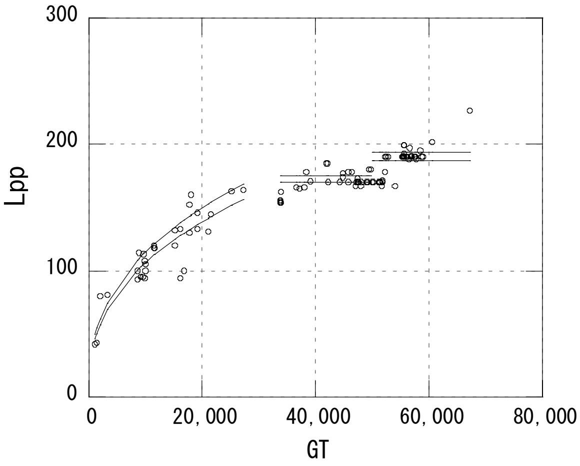
・50,000GT～

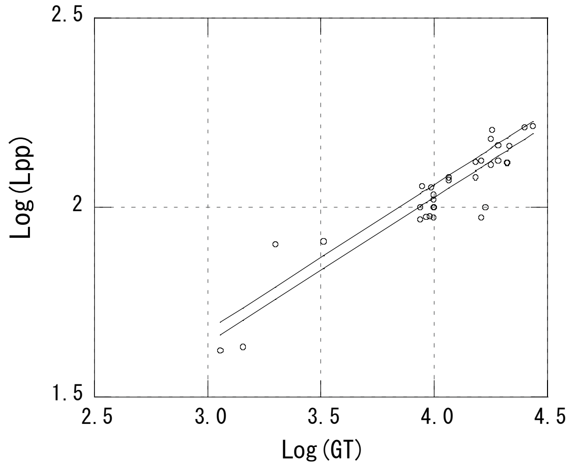
$Y=a_0$

(σ= 10.483)

	Average	75%
a_0	196.26	203.32

Figure 3-81 Pure Car Carrier Loa-GT





・～30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	3.0768	3.3234
β	0.3845	0.3845

・Greater than 30,000～Less than 50,000GT

$Y=a_0$

(σ= 7.200)

	Average	75%
a_0	170.23	175.08

・50,000GT～

$Y=a_0$

(σ= 10.157)

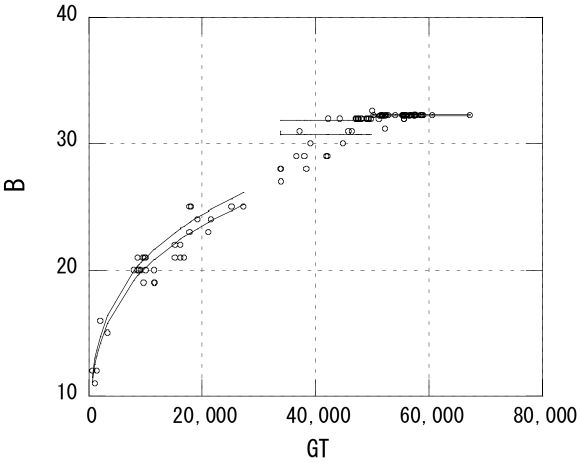
	Average	75%
a_0	186.97	193.82

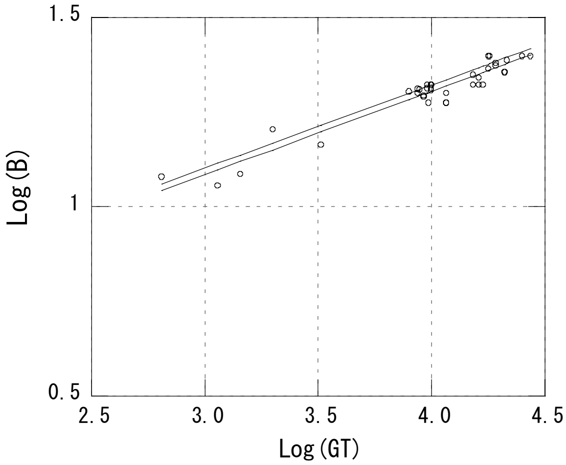
logY=a+blogX

(R^2= 0.827 , σ= 0.050)

	50%	75%
a	0.4881	0.5216
b	0.3845	0.3845

Figure 3-82 Pure Car Carrier Lpp-GT





・～30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	2.6709	2.7742
β	0.2195	0.2195

logY=a+blogX

(R^2= 0.897 , σ= 0.024)

	50%	75%
a	0.4267	0.4431
b	0.2195	0.2195

・Greater than 30,000～Less than 50,000GT

$Y=a_0$

（σ= 1.596 ）

	Average	75%
a_0	30.79	31.86

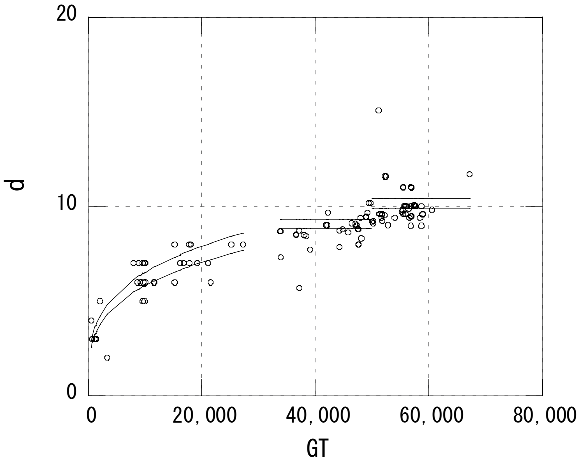
・50,000GT～

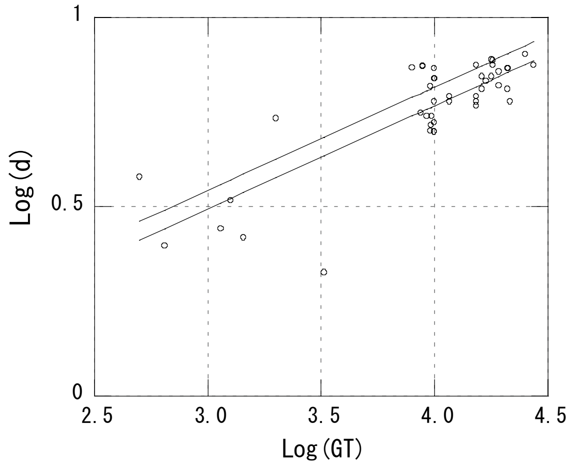
$Y=a_0$

（σ= 0.141 ）

	Average	75%
a_0	32.21	32.31

Figure 3-83 Pure Car Carrier B-GT





・～30,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.4759	0.5329
β	0.2722	0.2722

logY=a+blogX

(R^2= 0.667 , σ= 0.073)

	50%	75%
a	-0.3225	-0.2733
b	0.2722	0.2722

・Greater than 30,000～Less than 50,000GT

$Y=a_0$

(σ= 0.690)

	Average	75%
a_0	8.83	9.29

・50,000GT～

$Y=a_0$

(σ= 0.793)

	Average	75%
a_0	9.90	10.43

Figure 3-84 Pure Car Carrier d -GT

3.6 LPG Ship

Figure 3-85 to **Figure 3-87** show the results of analysis of Loa, B, and d for GT. And the following are the analysis method applied to each main dimension and the range of the ship classes to which each method was applied. **Table 3-12** shows the results of analysis of each main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-88**,**89**)
All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.979 for Loa and R^2 = 0.978 for Lpp.

(2) B (**Figure 3-90**)
All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.971.

(3) d (**Figure 3-91**)
All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.869.

Table 3-12 The results of analysis of main dimensions (LPG Ship)

Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
3,000	98	92	16.1	6.3
5,000	116	109	18.6	7.3
10,000	144	136	22.7	8.9
20,000	179	170	27.7	10.8
30,000	204	193	31.1	12.1
40,000	223	212	33.8	13.1
50,000	240	228	36.0	14.0

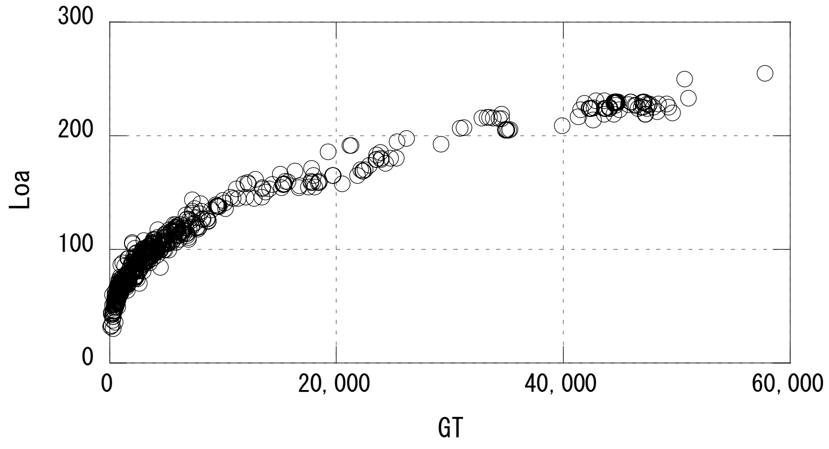


Figure 3-85 LPG Ship Loa-GT

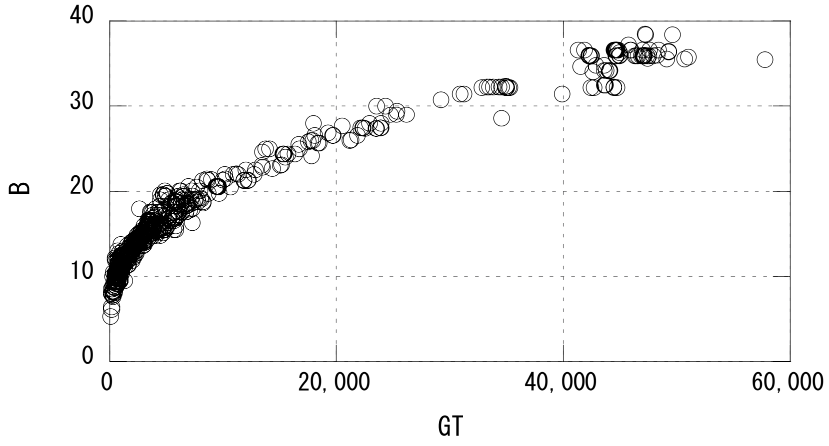


Figure 3-86 LPG Ship B-GT

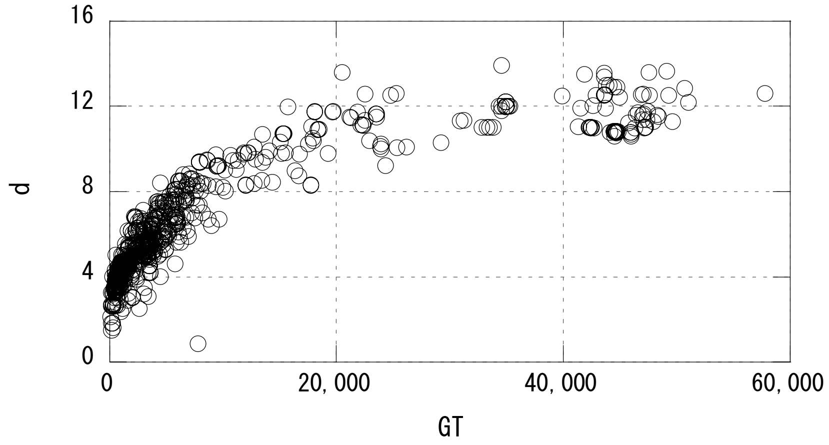
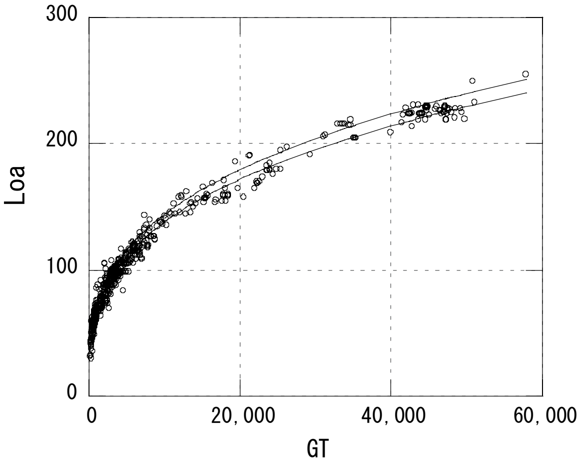
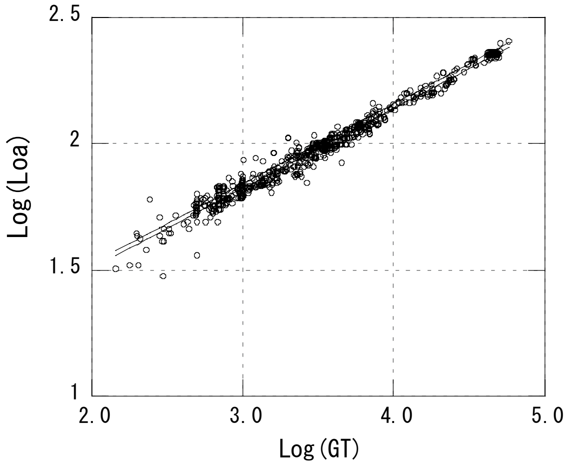


Figure 3-87 LPG Ship d-GT





$Y=\alpha \cdot X^{\beta}$

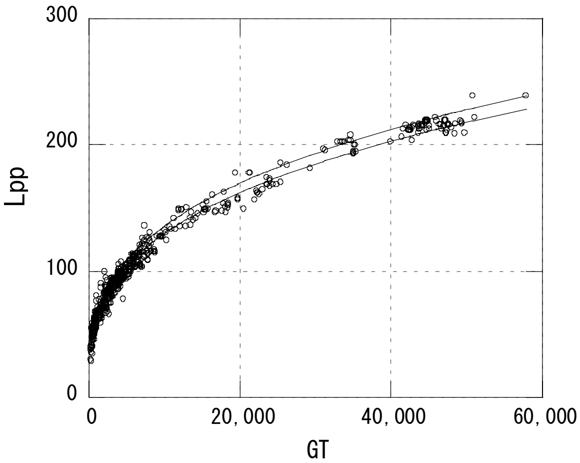
	50%	75%
α	7.4513	7.7815
β	0.3168	0.3168

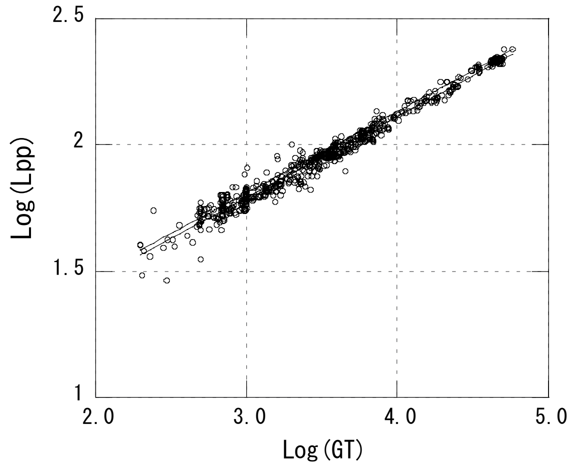
$\log Y=a+b\log X$

($R^2=$ 0.979 , $\sigma=$ 0.028)

	50%	75%
a	0.8722	0.8911
b	0.3168	0.3168

Figure 3-88 LPG Ship Loa-GT





$Y=\alpha \cdot X^{\beta}$

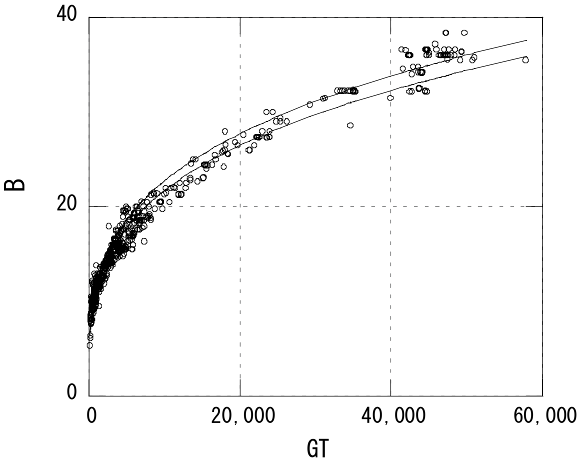
	50%	75%
α	6.6538	6.9589
β	0.3225	0.3225

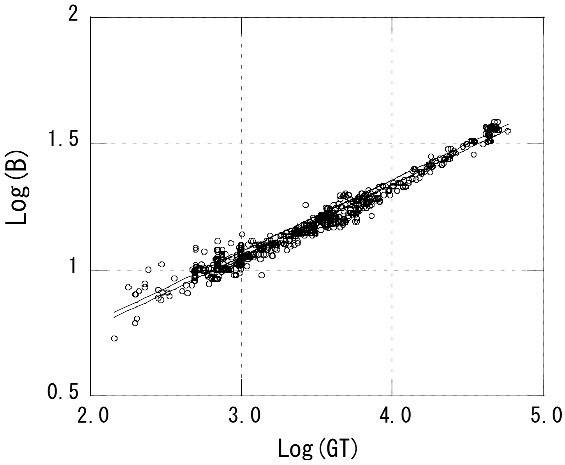
$\log Y=a+b\log X$

($R^2=$ 0.978 , $\sigma=$ 0.029)

	50%	75%
a	0.8231	0.8425
b	0.3225	0.3225

Figure 3-89 LPG Ship Lpp−GT





$Y=\alpha \cdot X^{\beta}$

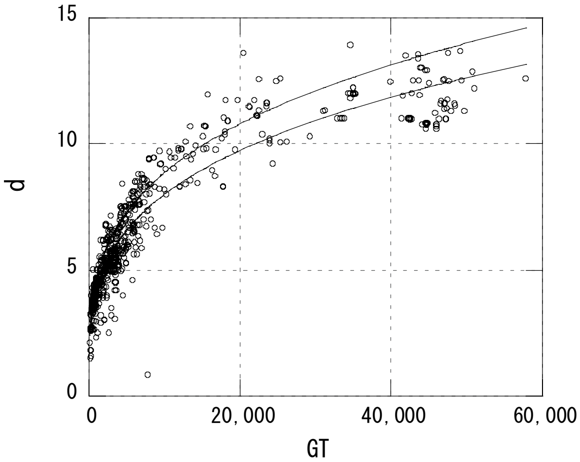
	50%	75%
α	1.5610	1.6348
β	0.2858	0.2858

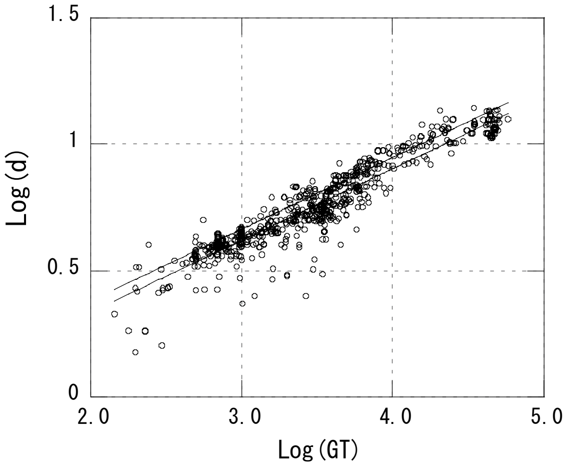
logY=a+blogX

(R^2= 0.971 , σ= 0.030)

	50%	75%
a	0.1934	0.2135
b	0.2858	0.2858

Figure 3-90 LPG Ship B−GT





$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.5867	0.6501
β	0.2837	0.2837

logY=a+blogX

(R^2= 0.869 , σ= 0.066)

	50%	75%
a	-0.2316	-0.1870
b	0.2837	0.2837

Figure 3-91 LPG Ship d−GT

3.7 LNG Ship

Figure 3-92 to **Figure 3-94**show the results of analysis of Loa, B, and d for GT. And the following are the analysis method applied to each main dimension and the range of the ship classes to which each method was applied. **Table 3-13** shows the results of analysis of each main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-95**, **96**)
All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.968 for Loa and R^2 = 0.972 for Lpp.

(2) B (**Figure 3-97**)
All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.986.

(3) d (**Figure 3-98**)
All ship classes were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.894.

Table 3-13 The results of analysis of main dimensions(LNG Ship)

Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
20,000	174	164	27.8	8.4
30,000	199	188	31.4	9.2
50,000	235	223	36.7	10.4
80,000	274	260	42.4	11.5
100,000	294	281	45.4	12.1

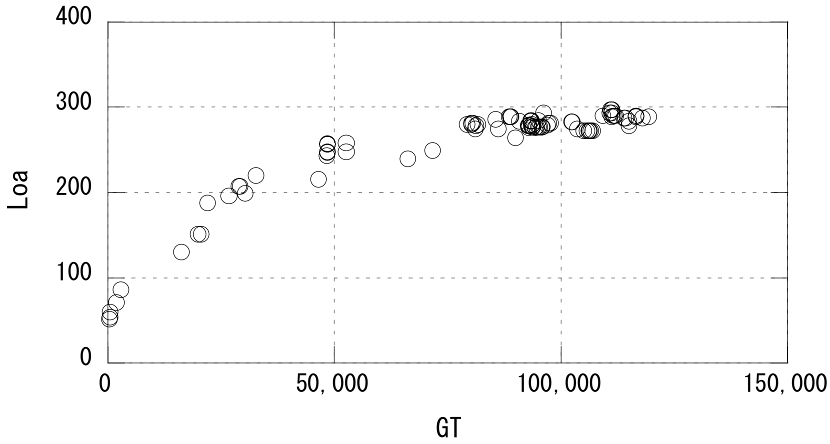


Figure 3-92 LNG Ship Loa-GT

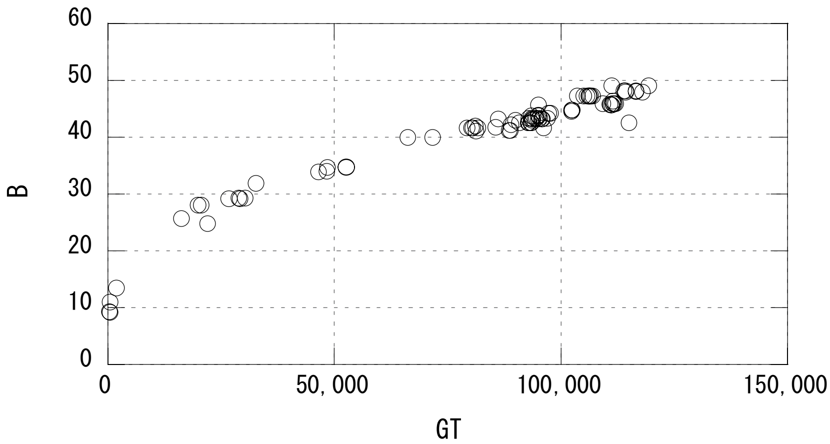


Figure 3-93 LNG Ship B-GT

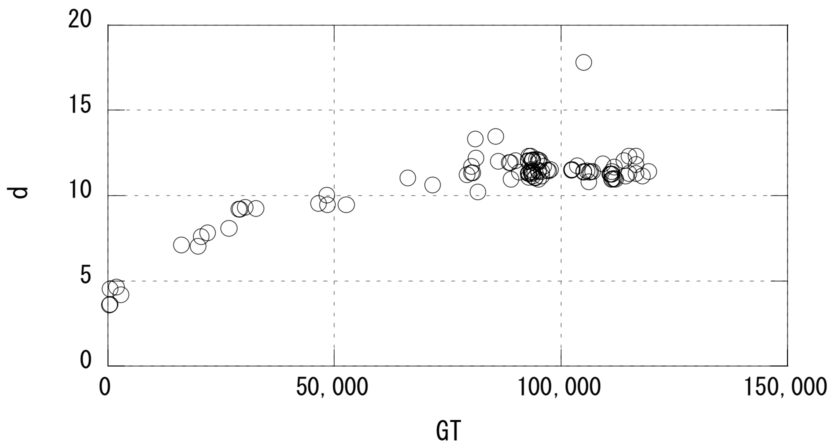
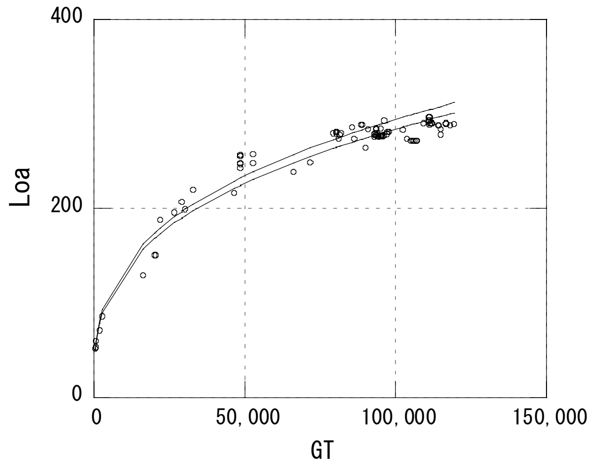
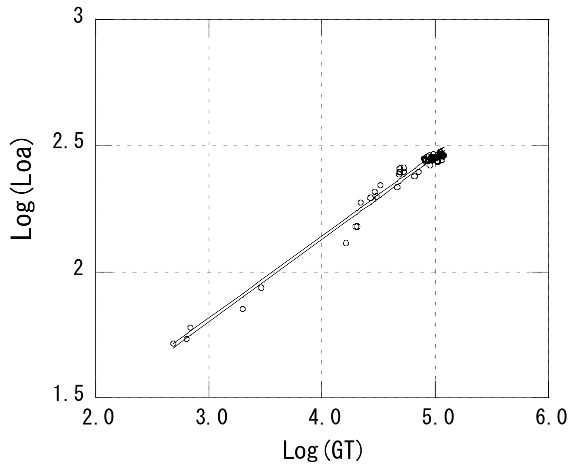


Figure 3-94 LNG Ship d-GT





$Y=\alpha \cdot X^{\beta}$

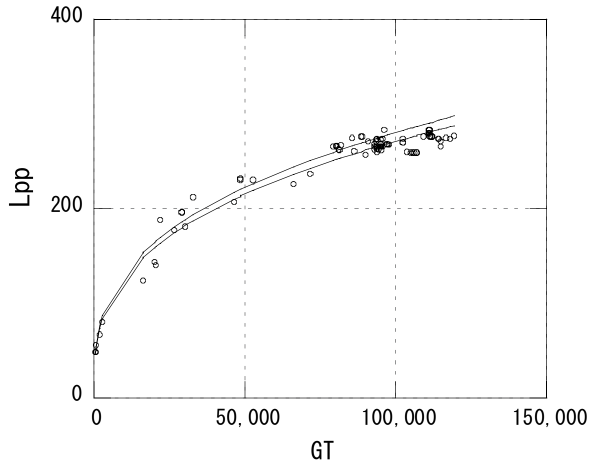
	50%	75%
α	6.6137	6.8499
β	0.3266	0.3266

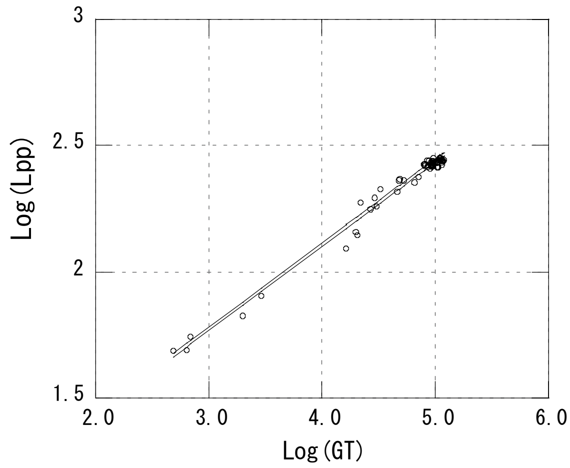
logY=a+blogX

(R^2= 0.968 , σ= 0.023)

	50%	75%
a	0.8204	0.8357
b	0.3266	0.3266

Figure 3-95 LNG Ship Loa−GT





$Y=\alpha \cdot X^{\beta}$

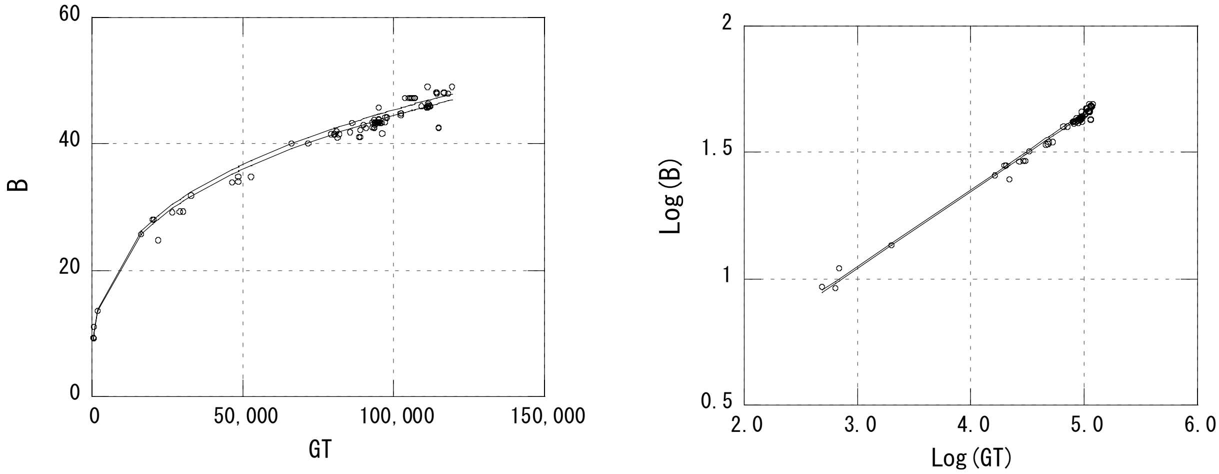
	50%	75%
α	5.8183	6.0194
β	0.3337	0.3337

logY=a+blogX

(R^2= 0.972 , σ= 0.022)

	50%	75%
a	0.7648	0.7796
b	0.3337	0.3337

Figure 3-96 LNG Ship Lpp−GT



$Y=\alpha \cdot X^{\beta}$

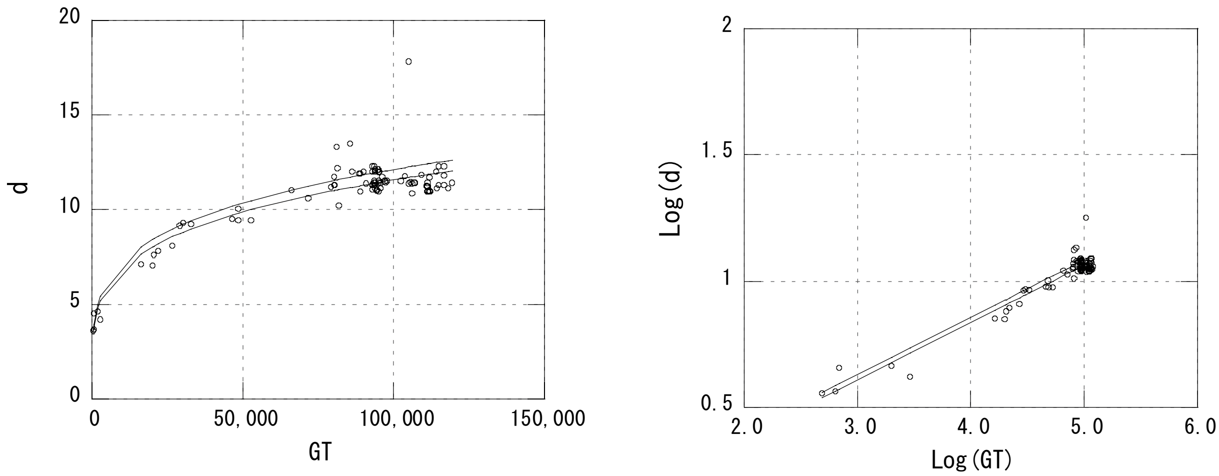
	50%	75%
α	1.3359	1.3633
β	0.3044	0.3044

$\log Y = a + b \log X$

(R^2= 0.986 , σ= 0.013)

	50%	75%
a	0.1258	0.1346
b	0.3044	0.3044

Figure 3-97 LNG Ship B−GT



$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.8437	0.8839
β	0.2274	0.2274

$\log Y = a + b \log X$

(R^2= 0.894 , σ= 0.030)

	50%	75%
a	-0.0738	-0.0536
b	0.2274	0.2274

Figure 3-98 LNG Ship d−GT

3.8 Passenger Ship

Figure 3-99 to **Figure 3-101** show the results of analysis of Loa, B, and d for GT. And the following are the analysis method applied to each main dimension and the range of the ship classes to which each method was applied. **Table 3-14** shows the results of analysis of each main dimension according to the ship class that was set.

(1) Loa, Lpp (**Figure 3-102**,**103**)
All ship classes (less than 100,000GT) were analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.942 for Loa and R^2 = 0.905 for Lpp.

(2) B (**Figure 3-104**)
The ships were divided into two classes with 50,000GT as the boundary, and less than 50,00GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.772. 50,000GT or more and less than 100,000GT was analyzed by the average value analysis method. And for 50,000DWT to 100,000DWT classes, instead of the average value, 32.3 m was used, assuming they are Panamax type.

(3) d (**Figure 3-105**)
The ships were divided into three classes with 20,000GT and 60,000GT as the boundaries, and less than 20,000GT was analyzed by the logarithmic regression analysis method, obtaining R^2 = 0.651. 20,000GT or more and less than 60,000GT and 60,000GT or more and less than 100,000GT were analyzed by the average value analysis method.

Table 3-14 The results of analysis of main dimensions(Passenger Ship)

Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
3,000	97	88	16.5	4.3
5,000	115	104	18.6	5.0
10,000	146	131	21.8	6.4
20,000	186	165	25.7	7.8
30,000	214	189	28.2	7.8
50,000	255	224	32.3	7.8
70,000	286	250	32.3	8.1
100,000	324	281	32.3	8.1

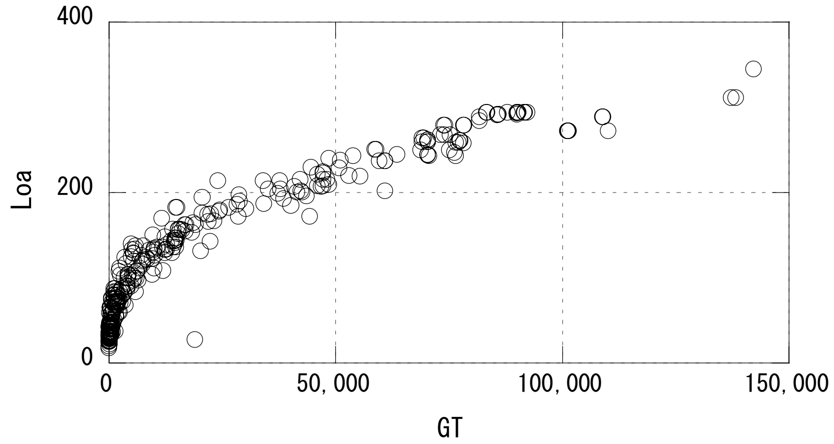


Figure 3-99 Passenger Ship Loa-GT

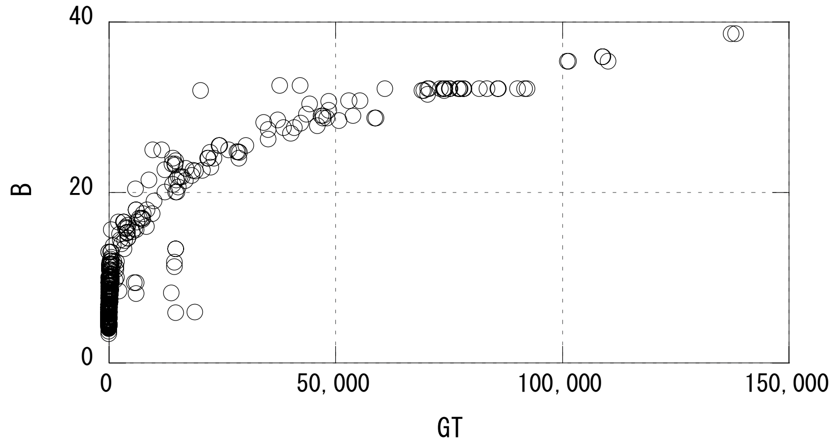


Figure 3-100 Passenger Ship B-GT

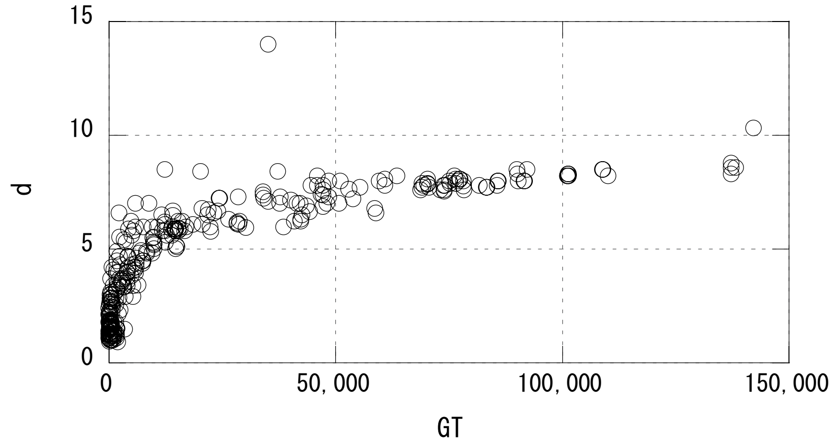
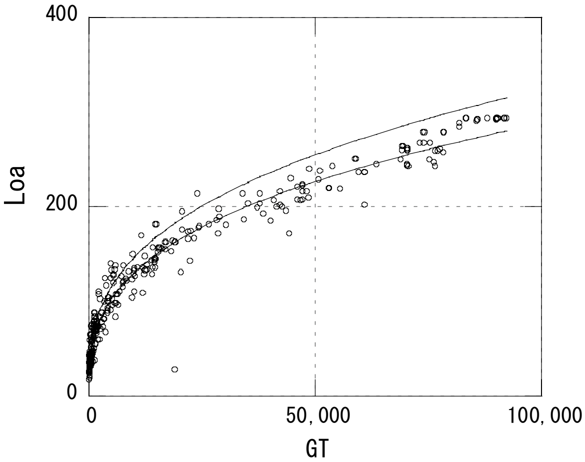
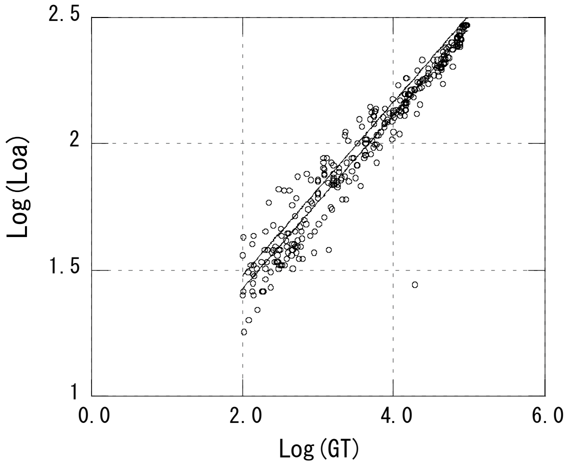


Figure 3-101 Passenger Ship d-GT





$Y=\alpha \cdot X^{\beta}$

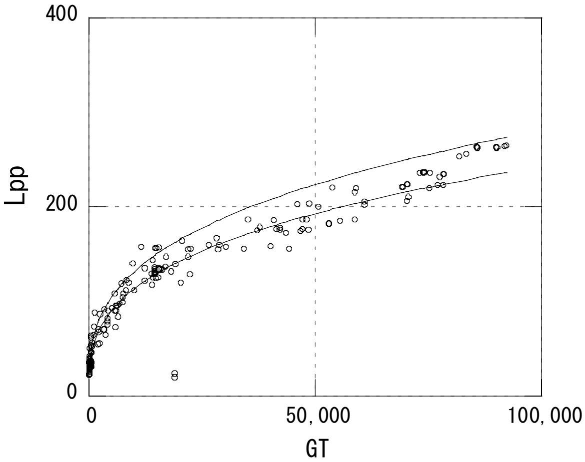
	50%	75%
α	5.4544	6.1331
β	0.3445	0.3445

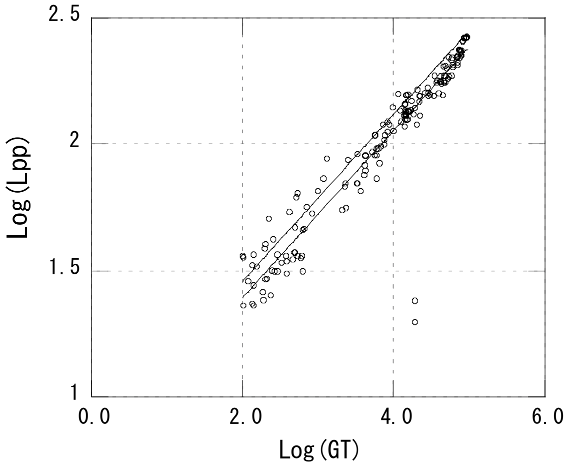
$\log Y = a + b \log X$

($R^2=$ 0.942 , σ= 0.076)

	50%	75%
a	0.7367	0.7877
b	0.3445	0.3445

Figure 3-102 Passenger Ship Loa−GT





$Y=\alpha \cdot X^{\beta}$

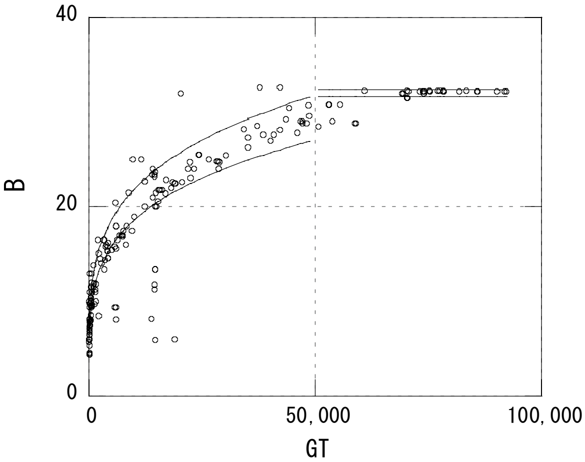
	50%	75%
α	5.3846	6.2400
β	0.3308	0.3308

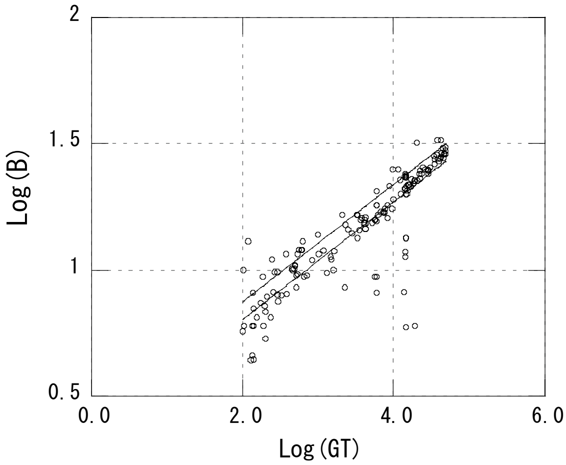
$\log Y = a + b \log X$

($R^2=$ 0.905 , σ= 0.095)

	50%	75%
a	0.7311	0.7952
b	0.3308	0.3308

Figure 3-103 Passenger Ship Lpp−GT





・～Less than 50,000GT

$$Y=\alpha\cdot X^{\beta}$$

	50%	75%
α	2.1757	2.5544
β	0.2330	0.2330

logY=a+blogX

(R^2= 0.772 , σ= 0.103)

	50%	75%
a	0.3376	0.4073
b	0.2330	0.2330

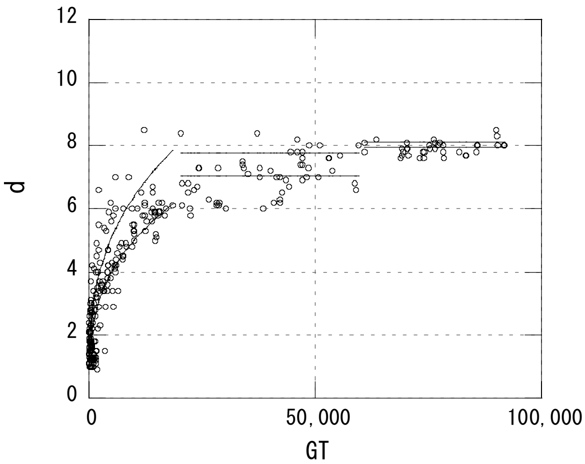
・50,000GT～100,000GT

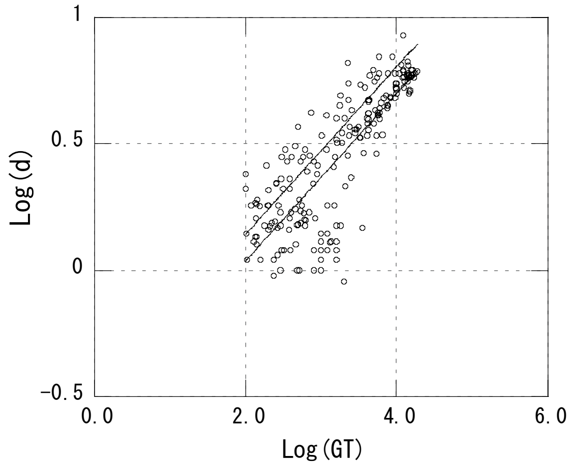
$Y=a_0$

(σ= 1.145)

	Average	75%
a_0	31.62	32.39

Figure 3-104 Passenger Ship B-GT





・～Less than 20,000GT

$Y=\alpha \cdot X^{\beta}$

	50%	75%
α	0.2359	0.3011
β	0.3317	0.3317

$\log Y = a + b \log X$

($R^2=$ 0.651 , σ= 0.157)

	50%	75%
a	-0.6273	-0.5214
b	0.3317	0.3317

・20,000GT～Less than 60,000GT

$Y=a_0$

(σ= 1.114)

	Average	75%
a_0	7.04	7.79

・60,000GT～100,000GT

$Y=a_0$

(σ= 0.231)

	Average	75%
a_0	7.95	8.11

Figure 3-105 Passenger Ship d-GT

3.9 Ferry

Figure 3-106 to **Figure 3-108** show the results of analysis of Loa, B, and d for GT. As **Figure 3-106** to **Figure 3-108** clearly show, the data for ferries is greatly scattered. Therefore, in cases where the logarithmic regression analysis method was applied to analyze all ship classes, it was impossible to guarantee that R^2 was 0.64 or more for all main dimensions. And even in a case where the logarithmic regression analysis method was applied to ships less than 1,000GT where the data appears to be concentrated on the diagram, it was impossible to guarantee that R^2 was 0.64 or more for the majority of the main dimensions. Therefore, statistical analysis was not performed for ferries.

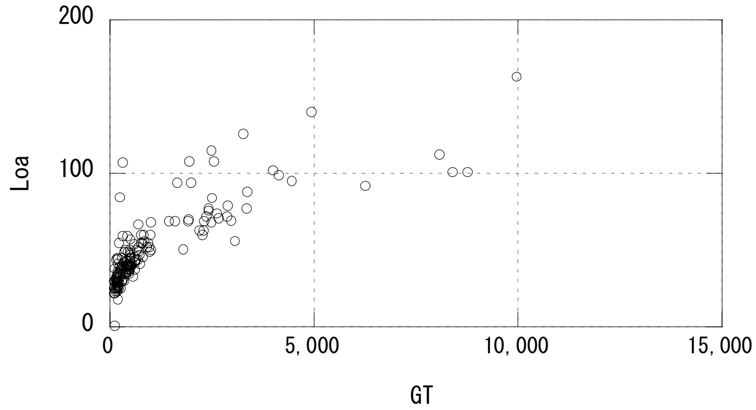


Figure 3-106 Ferry Loa-GT

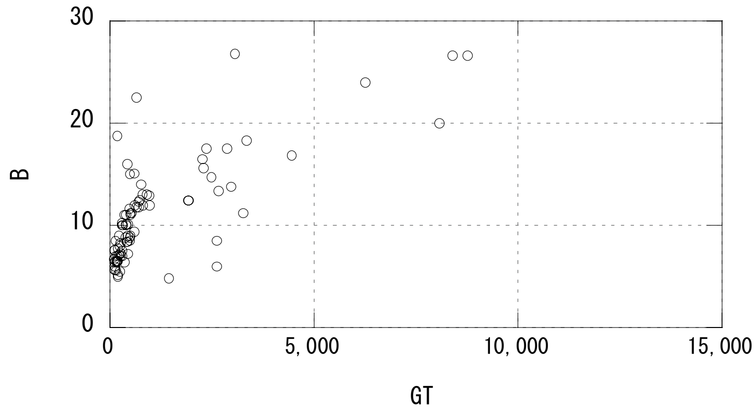


Figure 3-107 Ferry B-GT

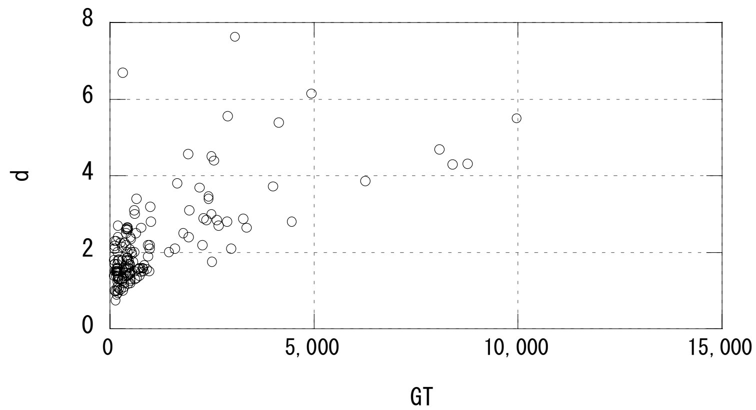


Figure 3-108 Ferry d-GT

4. Comparative evaluation of foreign standards etc. and main dimensions

4.1 Values of main dimensions in standards of foreign countries and organizations

As in Japan's Technical Standards and Commentaries of Port and Harbor Facilities, foreign countries and organizations stipulate the main dimensions of ships. These are the main dimensions of ships stipulated by the following countries, PIANC and other international bodies, documents etc. (below, "foreign standards etc.") These specific values are presented at the end of this report as **Appendix A**. These foreign standards etc. are only those in documents that could be collected by the Port and Harbour Department, National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport, and it is, of course, assumed that other documents exist. Of these, 6) Guidelines for Design of Fenders Systems, is the product of work performed with the participation of Researcher Akakura of the Systems Laboratory, Planning and Design Standards Division, Port and Harbour Research Institute, Ministry of Transport that is the predecessor of the Port Planning Division, Port and Harbour Department, National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport. It is impossible to confirm the source of the data analyzed nor the analysis method concerning the remainder from 1) to 5).

1)Port and Harbor Engineering : Gregory Tsinker, 1996(**TableA.1**)
2)Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996 : Issued by the Committee for Water front Structures of the Society for Harbours Engineering and the German Society for Soil Mechanics and Foundation Engineering, 1996(**TableA.2**)
3)Approach Channels A Guide for Design : Final Report of the Joint PIANC-IAPH Working Group Ⅱ-30 in cooperation with IMPA and IALA, 1997(**TableA.3**)
4)TECHNICAL CODES FOR PORT ENGINEERNIG : SECTOR STANDARDS OF THE PEOPLE'S REPUBLIC OF CHINA, 2000(**TableA.4**)
5)OBRAS MARIIMAS TECNOLOGIA : Puertos del Estado, 2000(**TableA.5**)
6)Guidelines for Design of Fenders Systems : Report of WG 33 of the MARITIME NAVIGATION COMMISSION , International Navigation Association PIANC, 2002 (**TableA.6** to **TableA.8**)

4.2 Comparison with foreign standards etc.

Table 4-1 compares the values of the main dimensions in these foreign standards etc. with the results of the analyses in 3.1 to 3.9. But because the categories and classes of ships vary in each case, it only includes categories and classes of ships that can be compared. And in 6) Guidelines for Design of Fenders Systems, the coverage rates are 50% values and 75% values, but here only 75% values are compared.

Table 4-1 shows indices of each of the foreign standards etc. in a case where the results of the analyses reported in this paper are assumed to be 100 along with the average values in 1) to 6). And **Figure 4-1** shows the fluctuations of values of six categories indexed by **Table 4-1**.

These results confirm that in a case where the results of the analysis in this report are the standard (100), the average values (for six categories of data) in the foreign standards etc. fluctuate within approximately ±5% (95% to 105%), and that this fluctuation range is exceeded by 10,000DWT class cargo ships (Loa), 30,000DWT class container ships (Loa) and by 50,000GT class passenger ships (d).

Based on these results, it can be concluded that the analytic values reported in this paper are values continuous with conventional foreign standards etc., and that because they are results of analysis of the newest data, they can be also be assessed as internationally standard values.

Table 4-1 Cass where the 2005 standard is assumed to be 100

10,000DWT Class General Cargo Ship

	DWT	Loa	%	B	%	d	%
1) HANDBOOK OF PORT AND HARBOR ENGINEER	10,000	142	108	19.0	92	8.3	102
2) Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996	11,000	150	114	20.0	97	9.0	111
3) Approach Channels A Guide for Design	10,000	133	101	19.8	96	8.0	99
4) SECTOR STANDARDS OF THE PEOPLE'S REPUBLIC OF CHINA	10,000	153	116	20.0	97	8.8	109
5) OBRAS MARIMAS TECNOLOGIA 2000	10,000	133	101	19.8	96	8.0	99
6) Guidelines for the Desigh of Fenders Systems:2002 75%	10,000	137	104	20.5	99	8.3	102
7) The results of the analyses reported in this paper	10,000	132	100	20.7	100	8.1	100
Average 1)～6)			107		96		104

30,000DWT Class Container Ship

	DWT	Loa	%	B	%	d	%
1) HANDBOOK OF PORT AND HARBOR ENGINEER	-	-		-		-	
2) Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996	30,000	228	112	31.0	101	11.3	101
3) Approach Channels A Guide for Design	30,000	210	103	30.0	98	10.7	96
4) SECTOR STANDARDS OF THE PEOPLE'S REPUBLIC OF CHINA	30,000	237	117	31.0	101	11.5	103
5) OBRAS MARIMAS TECNOLOGIA 2000	30,000	210	103	30.0	98	10.7	96
6) Guidelines for the Desigh of Fenders Systems:2002 75%	30,000	218	107	30.2	99	11.1	99
7) The results of the analyses reported in this paper	30,000	203	100	30.6	100	11.2	100
Average 1)～6)			109		99		99

50,000DWT Class Container Ship

	DWT	Loa	%	B	%	d	%
1) HANDBOOK OF PORT AND HARBOR ENGINEER	-	-		-		-	
2) Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996	50,000	290	106	32.4	100	13.0	102
3) Approach Channels A Guide for Design	50,000	267	97	32.2	100	12.5	98
4) SECTOR STANDARDS OF THE PEOPLE'S REPUBLIC OF CHINA	50,000	294	107	35.0	108	13.3	105
5) OBRAS MARIMAS TECNOLOGIA 2000	50,000	267	97	32.2	100	12.5	98
6) Guidelines for the Desigh of Fenders Systems:2002 75%	50,000	266	97	32.3	100	13.0	102
7) The results of the analyses reported in this paper	50,000	274	100	32.3	100	12.7	100
Average 1)～6)			101		102		101

70,000DWT Class Oil Tanker

	DWT	Loa	%	B	%	d	%
1) HANDBOOK OF PORT AND HARBOR ENGINEER	70,000	248	109	35.7	94	13.4	104
2) Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996	-	-		-		-	
3) Approach Channels A Guide for Design	70,000	225	99	38.0	100	13.5	105
4) SECTOR STANDARDS OF THE PEOPLE'S REPUBLIC OF CHINA	80,000	250	110	38.0	100	13.6	105
5) OBRAS MARIMAS TECNOLOGIA 2000	70,000	225	99	38.0	100	13.5	105
6) Guidelines for the Desigh of Fenders Systems:2002 75%	70,000	235	103	38.0	100	13.9	108
7) The results of the analyses reported in this paper	70,000	228	100	38.1	100	12.9	100
Average 1)～6)			104		99		105

50,000GT Class Passenger Ship

	GT	Loa	%	B	%	d	%
1) HANDBOOK OF PORT AND HARBOR ENGINEER	50,000	245	96	30.5	94	10.5	135
2) Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996	50,000	300	118	31.0	96	10.5	135
3) Approach Channels A Guide for Design	50,000	234	92	32.2	100	7.1	91
4) SECTOR STANDARDS OF THE PEOPLE'S REPUBLIC OF CHINA	-	-		-		-	
5) OBRAS MARIMAS TECNOLOGIA 2000	50,000	234	92	32.2	100	7.1	91
6) Guidelines for the Desigh of Fenders Systems:2002 75%	50,000	248	97	32.3	100	8.0	103
7) The results of the analyses reported in this paper	50,000	255	100	32.3	100	7.8	100
Average 1)～6)			99		98		111

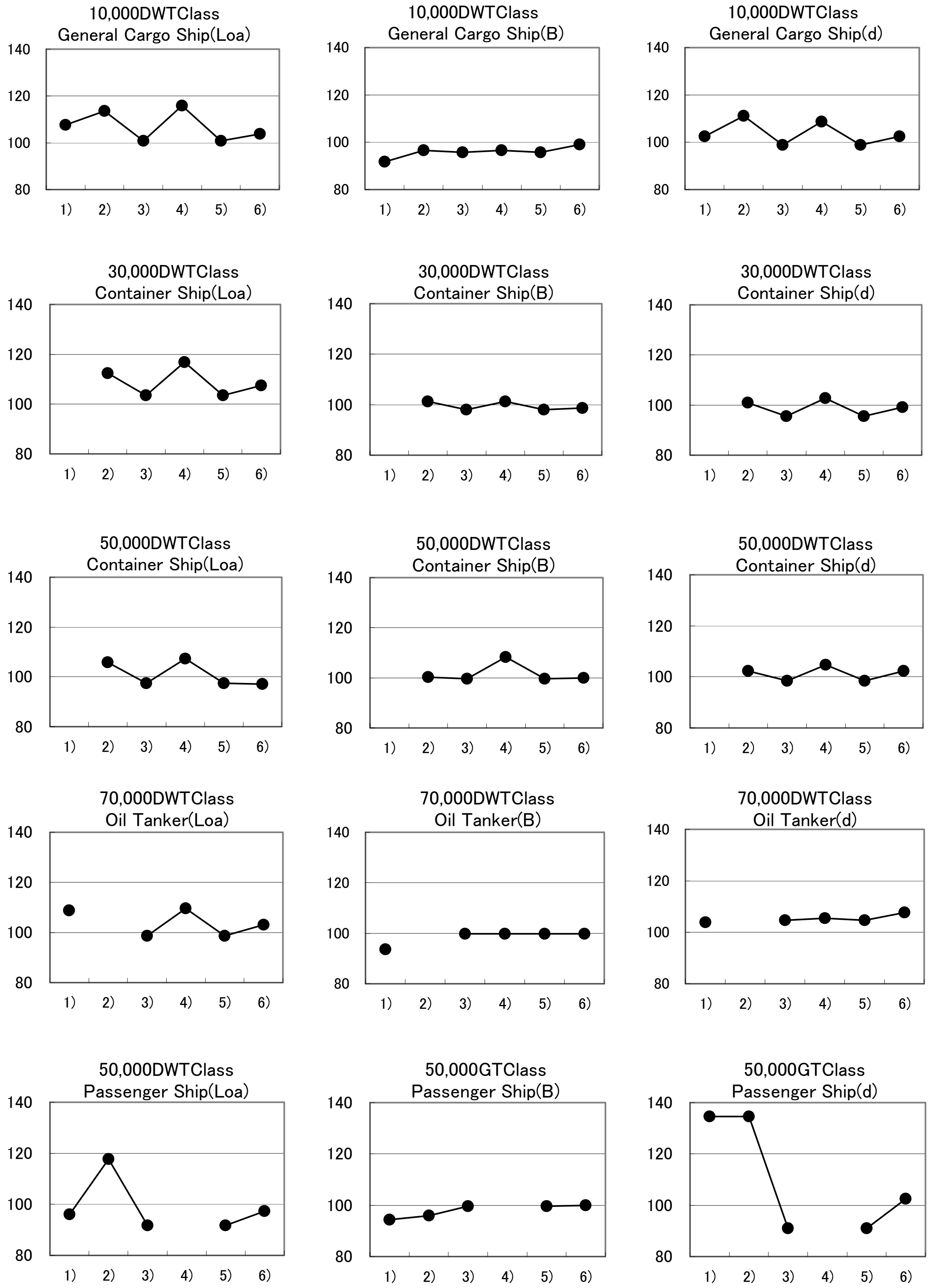


Figure 4-1 Cass where the 2005 standard is assumed to be 100

5. Items analyzed other than the main dimensions of ships

In Part **3**, Loa, Lpp, B, and d were analyzed for GT or for DWT, but items in addition to these main dimensions are necessary to plan and design port facilities. For example, there are cases where the values of GT for DWT are required. And the displacement tonnage (DSP), block coefficient (Cb), wind projected front area (Ax), the wind projected lateral area (Ay) of the ships are required to calculate the impact produced when a ship berths or to design the scale of the fairway. Therefore, the results of the analysis of these items performed similarly to that of the main dimensions are presented below. And these items show equations for simple regression analysis, or in other words, as equations with a coverage rate of 50%. But, the regression equation for an optional coverage rate can be set based on the standard differential from the regression equation that is also shown.

5.1 Gross tonnage (GT) and dead weight tonnage (DWT)

The GT for DWT is obtained by applying the linear regression analysis method that passes through the origin points for all categories of ship and the results of this analysis are shown in **Table 5-1** and in **Figure 5-1** to **Figure 5-8**.

Table 5-1 The relations between DWT and GT of each ship type

Type	Regression	Coefficients of determination(R^2)	Standard deviation (σ)
General Cargo Ship	GT = 0.5285DWT	0.988	2,202
Container Ship	GT = 0.8817DWT	0.971	3,735
Oil Tanker	GT = 0.5354DWT	0.992	4,276
Roll-on/Roll-off Ship	GT = 1.7803DWT	0.752	7,262
Pure Car Carrier	GT = 2.7214DWT	0.826	7,655
LPG Ship	GT = 0.8447DWT	0.988	1,513
LNG Ship	GT = 1.3702DWT	0.819	12,439
Passenger Ship	GT = 8.9393DWT	0.862	12,285

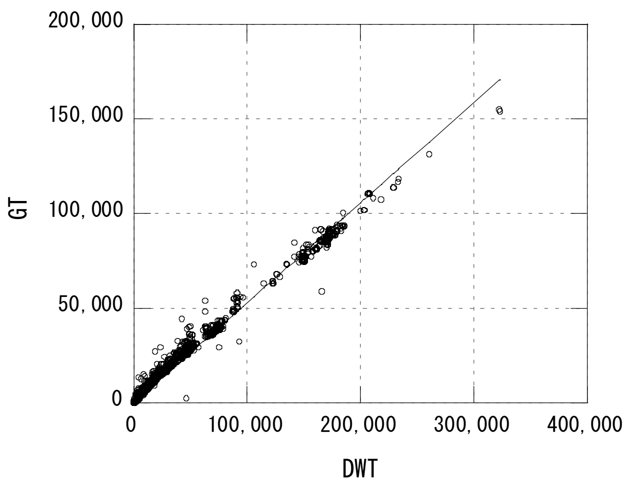


Figure 5-1 Cargo Ship DWT-GT

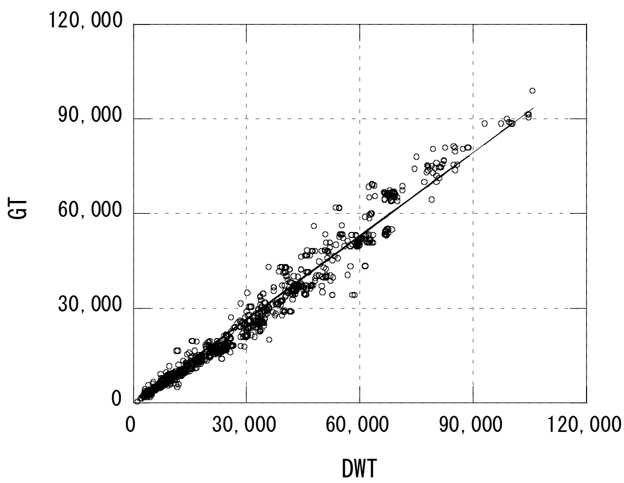


Figure 5-2 Container Ship DWT-GT

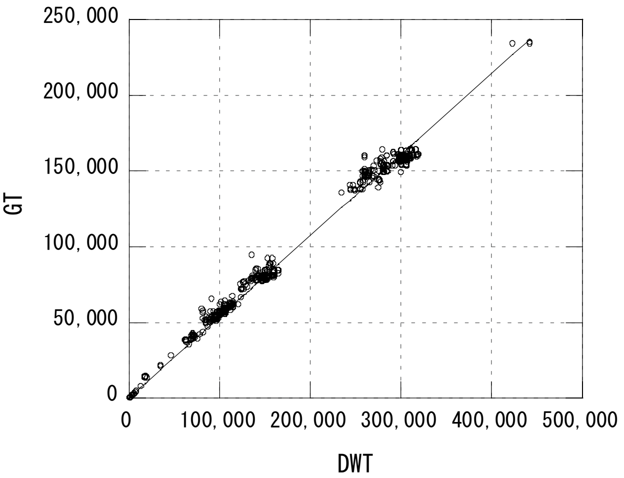


Figure 5-3 Oil Tanker DWT-GT

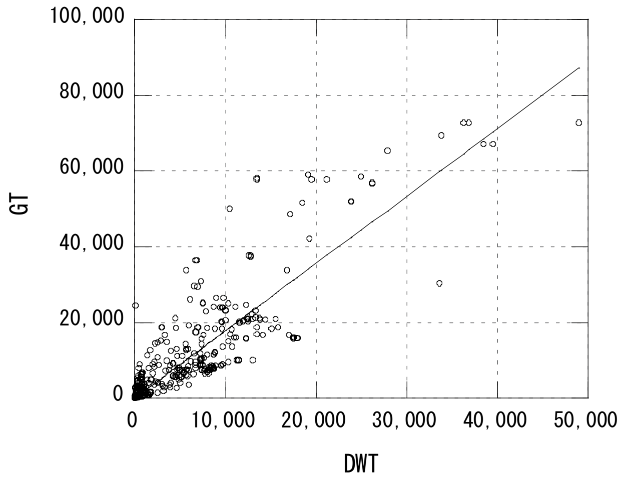


Figure 5-4 Roll-on/Roll-off Ship DWT-GT

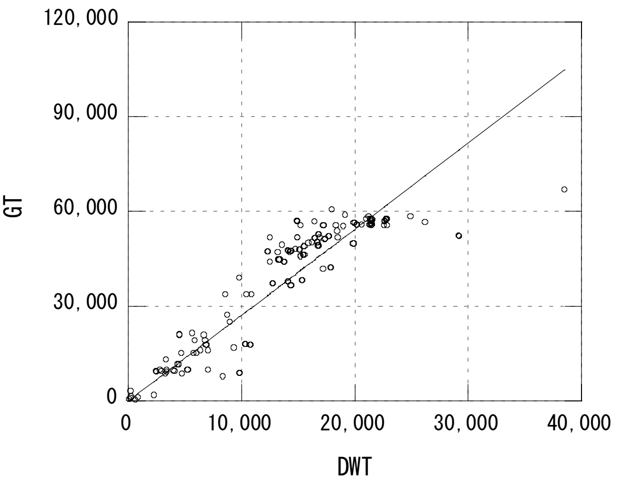


Figure 5-5 Pure Car Carrier Ship DWT-GT

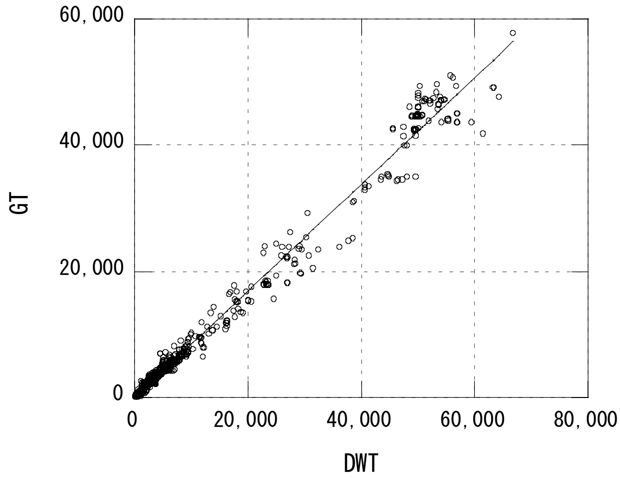


Figure 5-6 LPG Ship DWT-GT

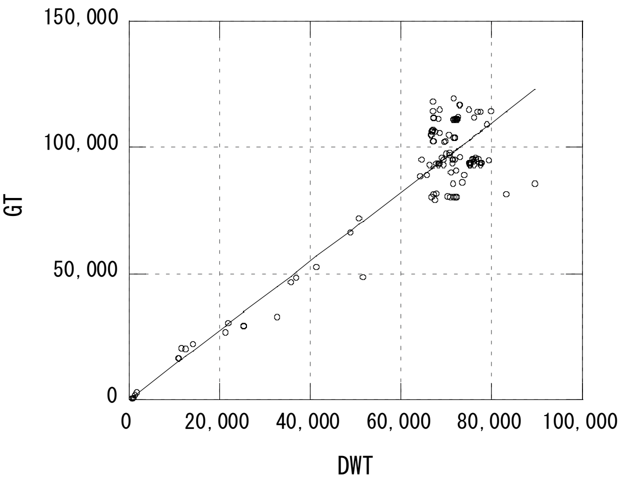


Figure 5-7 LNG Ship DWT-GT

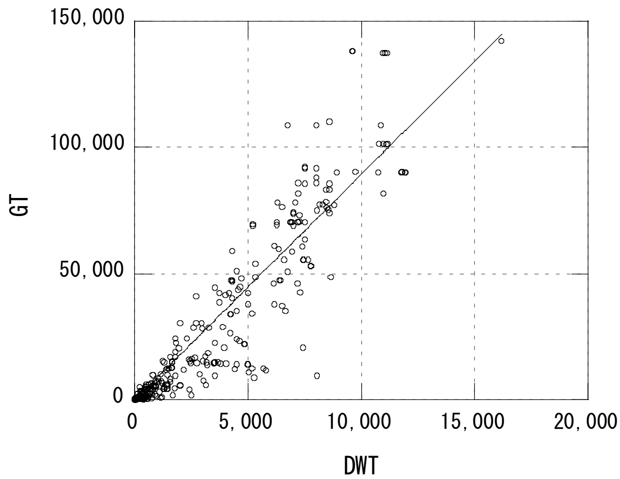


Figure 5-8 Passenger Ship DWT-GT

5.2 Displacement tonnage (DSP) and gross tonnage (GT) or dead weight tonnage (DWT)

The DSP for DWT or GT is obtained by applying the linear regression analysis method that passes through the origin points for all categories of ship and the results of this analysis are shown in **Table 5-2** and in **Figure 5-9** to **Figure 5-16**

Table 5-2 The relations between DWT(GT) and DSP of each ship type

Type	Regression	Coefficients of determination(R^2)	Standard deviation (σ)
General Cargo Ship	DSP = 1.1389DWT	0.998	2,234
Container Ship	DSP = 1.3443DWT	0.992	2,668
Oil Tanker	DSP = 1.1375DWT	0.992	8,743
Roll-on/Roll-off Ship	DSP = 0.8796GT	0.804	4,866
Pure Car Carrier	DSP = 0.6523GT	0.917	3,565
LPG Ship	DSP = 1.1139GT	0.912	10,199
LNG Ship	DSP = 1.0145GT	0.884	8,641
Passenger Ship	DSP = 0.5215GT	0.957	2,745

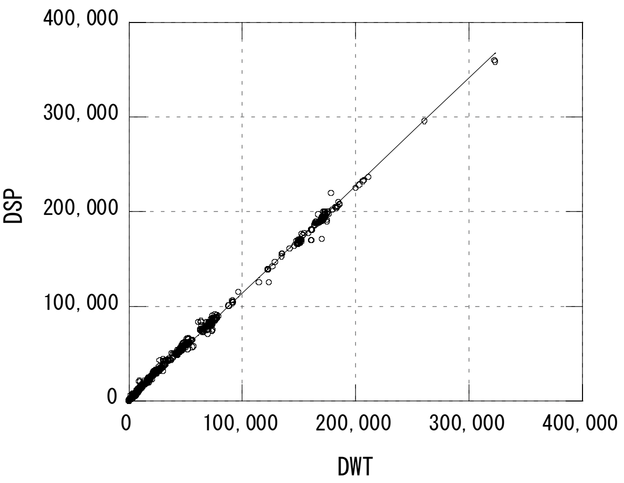


Figure 5-9 Cargo Ship DWT-DSP

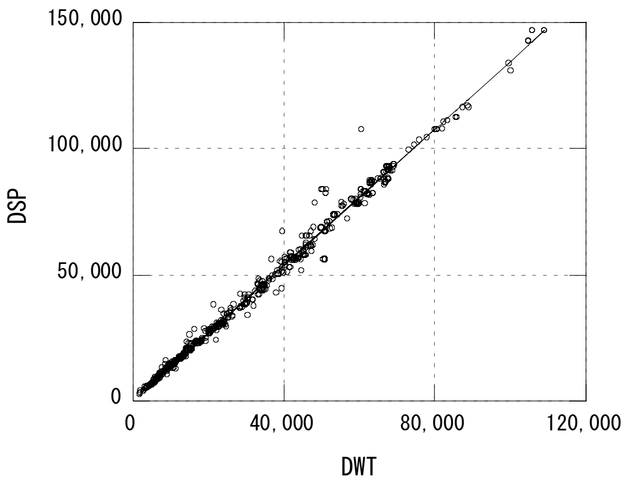


Figure 5-10 Container Ship DWT-DSP

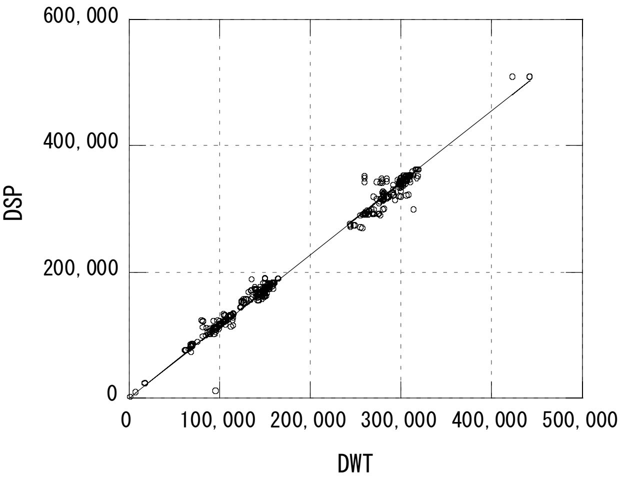


Figure 5-11 Oil Tanker DWT-DSP

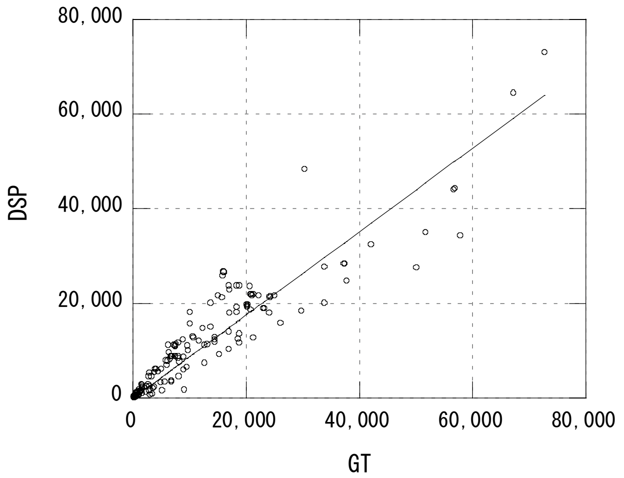


Figure 5-12 Roll-on/Roll-off Ship DSP-GT

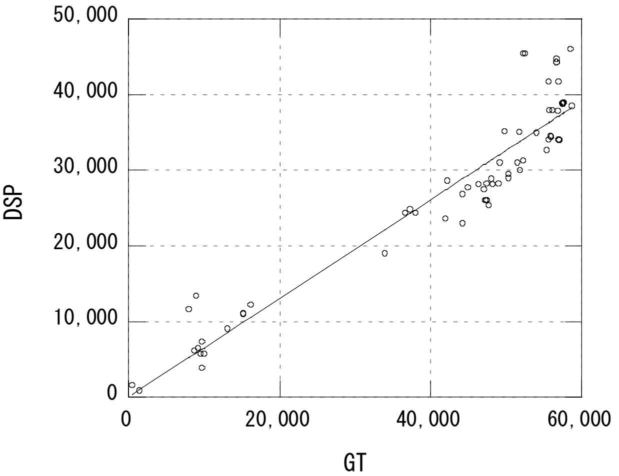


Figure 5-13 Pure Car Carrier Ship DSP-GT

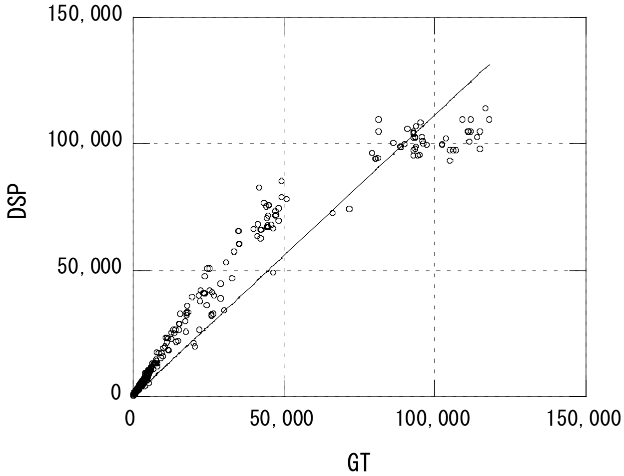


Figure 5-14 LPG Ship GT-DSP

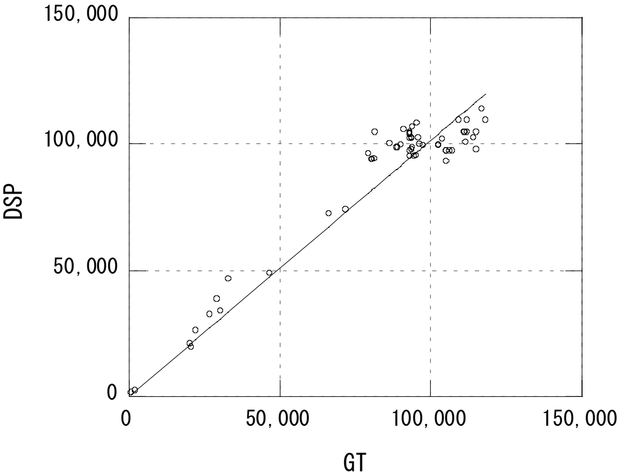


Figure 5-15 LNG Ship GT-DSP

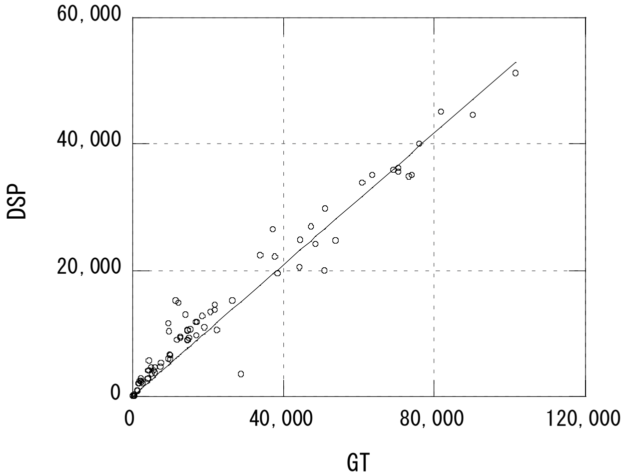


Figure 5-16 Passenger Ship GT-DSP

5.3 Block coefficient (Cb) and gross tonnage (GT) or dead weight tonnage (DWT)

The results of analyzing Cb calculated by the following equation for DWT or for GT are shown in **Figure 5-17** to **Figure 5-24**. It was analyzed only for the results of 0.4 to 1.0 considering the properties of Cb. From this figure, the average value analysis method was applied, with its results shown in **Table 5-3**. So Cb is the value calculated by the following equation.

Cb＝DSP／（Lpp・Ｂ・ｄ・sea water density）

Table 5-3 Block coefficient (Cb)

Type	50%	Standard deviation (σ)
General Cargo Ship	0.804	0.0712
Container Ship	0.668	0.0472
Oil Tanker	0.824	0.0381
Roll-on/Roll-off Ship	0.670	0.1140
Pure Car Carrier	0.594	0.0665
LPG Ship	0.737	0.0620
LNG Ship	0.716	0.0399
Passenger Ship	0.591	0.0595

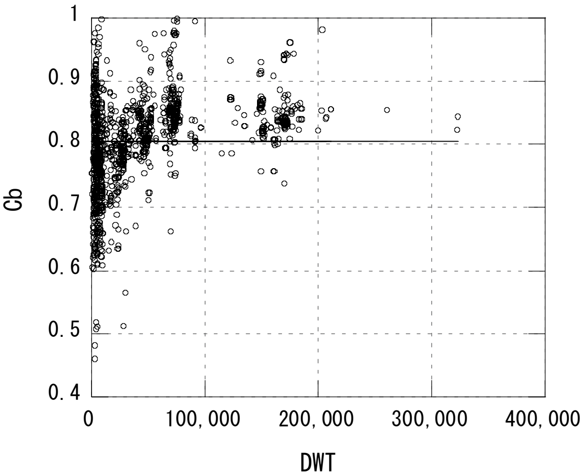


Figure 5-17 Cargo Ship DWT-Cb

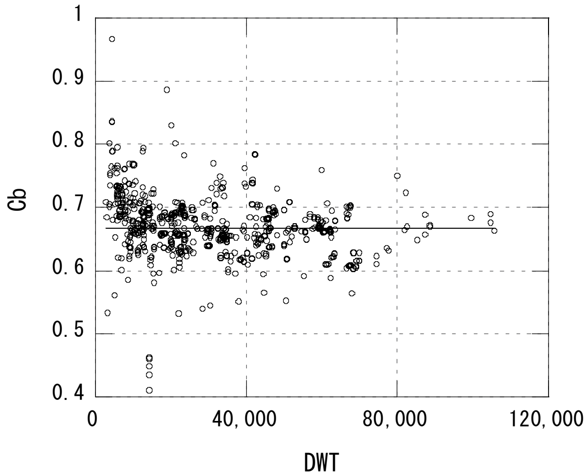


Figure 5-18 Container Ship　DWT-Cb

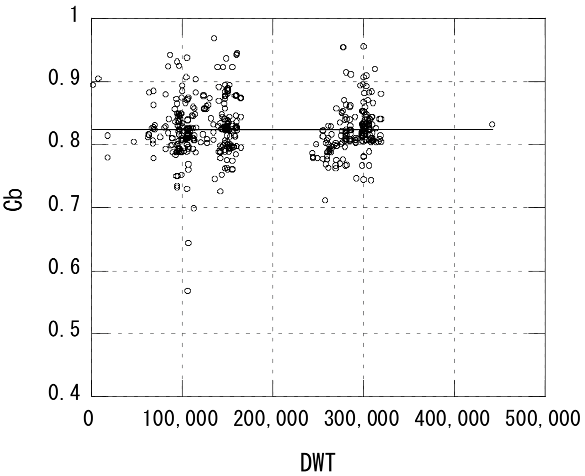


Figure 5-19 Oil Tanker DWT-Cb

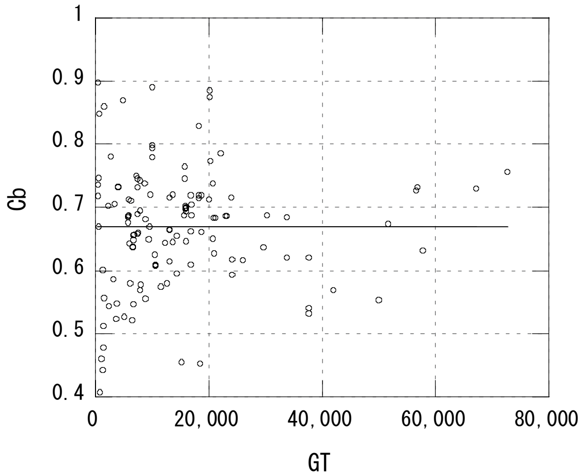


Figure 5-20　Roll-on/Roll-off Ship Cb-GT

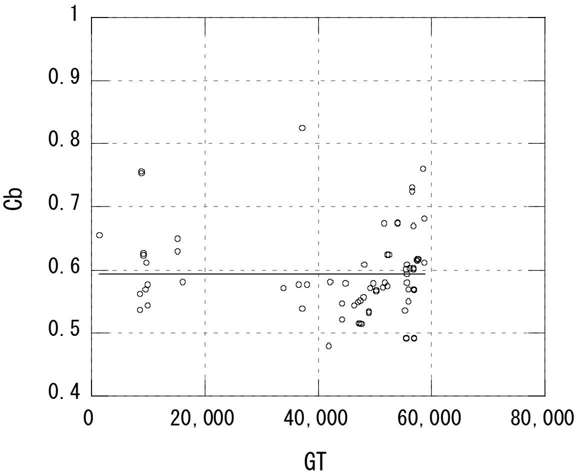


Figure 5-21 Pure Car Carrier Ship Cb-GT

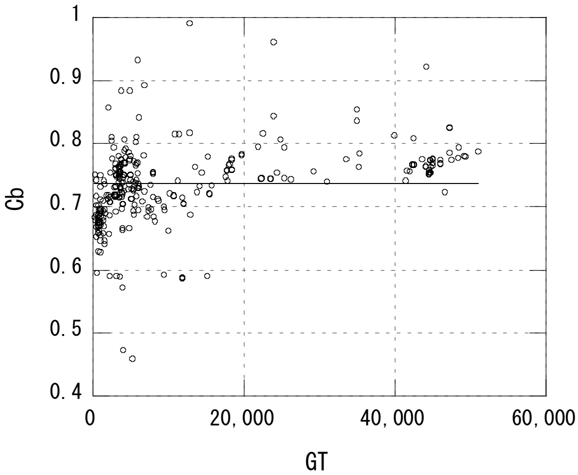


Figure 5-22 LPG Ship GT-Cb

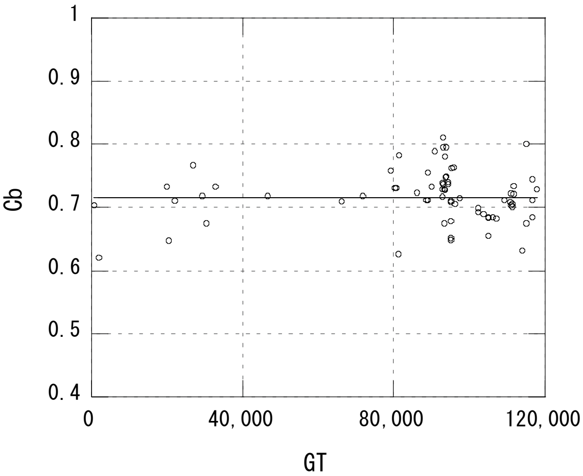


Figure 5-23 LNG Ship GT-Cb

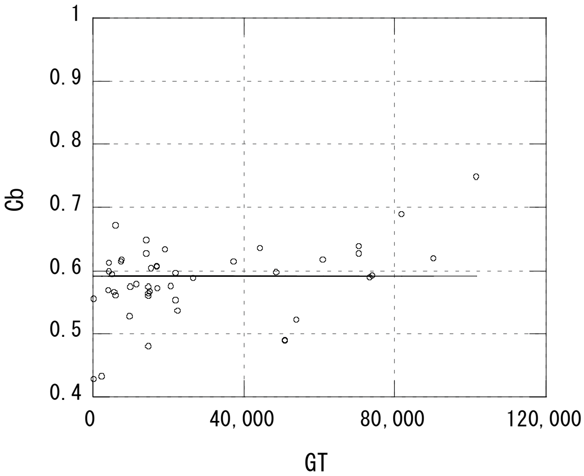


Figure 5-24 Passenger Ship GT-Cb

5.4 Wind projected front area (Ax) and the wind projected lateral area (Ay)

Because it is difficult to obtain new data for Ax and Ay, **Table 5-4** shows the results of the following equation proposed by Akakura and Takahashi [3]. Here the category “cargo ship” is further are categorized as general cargo ship and as bulk carrier.

$$\log_{10}(Y) = \alpha_w + \beta_w \cdot \log_{10}(X)$$

Where:

Y : Ax or Ay (m^2)

X : DWT or GT of the ship analyzed (tons)

α_w, β_w : coefficients

Table 5-4 Coefficient used to estimate Ax, Ay

1)Fully loaded

	Unit	Coefficient used to estimate A_x				Coefficient used to estimate A_y			
		α_w	β_w	R^2	σ	α_w	β_w	R^2	σ
Gneral Cargo Ship	DWT	−0.228	0.666	0.929	0.0451	0.507	0.616	0.824	0.1302
Bulk Carrier	DWT	0.944	0.370	0.823	0.0497	1.218	0.425	0.841	0.0729
Container Ship	DWT	0.136	0.609	0.812	0.0598	0.417	0.703	0.949	0.0675
Oil Tanker	DWT	0.469	0.474	0.901	0.0625	0.556	0.558	0.931	0.0708
Roll-on/Roll-off Ship	DWT	1.029	0.435	0.901	0.0469	1.453	0.464	0.719	0.1453

2)With ballast

	Unit	Coefficient used to estimate A_x				Coefficient used to estimate A_y			
		α_w	β_w	R^2	σ	α_w	β_w	R^2	σ
Gneral Cargo Ship	DWT	0.099	0.615	0.935	0.0365	0.479	0.662	0.906	0.1007
Bulk Carrier	DWT	0.629	0.469	0.935	0.0376	0.970	0.530	0.956	0.0460
Container Ship	DWT	0.574	0.526	0.696	0.0741	0.731	0.625	0.819	0.1016
Oil Tanker	DWT	0.251	0.551	0.962	0.0408	0.650	0.592	0.984	0.0333
Roll-on/Roll-off Ship	DWT	0.917	0.473	0.910	0.0453	1.541	0.456	0.792	0.1123

6. Summary tables

Table 6-1 organize all the items analyzed as reported in Part **3**. Here, not only the 75% coverage rate, but the results of analysis for the 50% coverage rate and for the 95% coverage rate are also shown. The breadth molded: B that is one of the analytic items was not corrected as Panamax type as it was done in **3.1**, **3.2**, and **3.8**.

Table 6-1 Ship Dimensions

・Coverage rate：50%

Type	Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
Cargo Ship	5,000	101	94	15.9	5.8
	7,000	111	104	17.5	6.5
	10,000	123	116	19.4	7.3
	15,000	139	131	21.8	8.4
	20,000	151	143	23.7	9.2
	30,000	170	162	26.6	10.0
	50,000	198	189	30.7	11.8
	70,000	219	210	33.8	13.2
	100,000	243	234	37.4	14.8
	150,000	274	264	42.0	16.9
	200,000	298	289	45.6	18.5
	300,000	336	326	51.2	21.1
Container Ship	5,000	105	97	17.2	6.1
	7,000	118	109	19.0	6.8
	10,000	133	124	21.2	7.6
	15,000	154	143	23.9	8.7
	20,000	170	159	26.1	9.5
	30,000	195	183	29.5	10.8
	50,000	261	246	32.4	12.3
	70,000	281	268	38.7	13.8
	100,000	342	330	42.6	14.6
Oil Tanker	5,000	95	94	15.4	5.7
	7,000	104	105	16.8	6.3
	10,000	136	129	19.9	6.9
	15,000	151	143	22.6	7.8
	20,000	162	155	24.8	8.4
	30,000	180	172	28.2	9.4
	50,000	205	196	33.1	10.9
	70,000	223	214	36.9	12.3
	100,000	244	234	41.3	14.0
	150,000	271	260	47.0	16.4
	200,000	330	317	58.2	18.3
	300,000	330	317	58.2	21.3

Type	Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
Roll-on/ Roll-off	5,000	105	96	18.2	4.7
	7,000	118	109	19.6	5.2
	10,000	133	124	21.3	5.9
	15,000	154	144	23.4	6.7
	20,000	170	159	25.0	7.4
	40,000	187	170	32.3	9.5
	50,000	199	181	32.3	9.5
	60,000	199	181	32.3	9.5
Pure Car Carrier Ship	5,000	95	81	17.3	4.8
	7,000	105	93	18.6	5.3
	10,000	117	106	20.2	5.8
	15,000	132	124	22.0	6.5
	20,000	144	139	23.5	7.1
	30,000	162	162	25.7	7.9
	40,000	180	170	30.8	8.8
	50,000	196	187	32.2	9.9
	60,000	196	187	32.2	9.9
LPG Ship	5,000	111	104	17.8	6.6
	7,000	123	116	19.6	7.2
	10,000	138	130	21.7	8.0
	15,000	157	148	24.4	9.0
	20,000	172	162	26.5	9.7
	30,000	195	185	29.7	10.9
	50,000	230	218	34.4	12.6
	60,000	243	231	36.2	13.3
LNG Ship	5,000	107	100	17.9	5.9
	7,000	119	112	19.8	6.3
	10,000	134	126	22.0	6.9
	15,000	153	144	24.9	7.5
	20,000	168	159	27.2	8.0
	30,000	192	181	30.8	8.8
	50,000	227	215	36.0	9.9
	70,000	253	241	39.9	10.7
	100,000	284	271	44.4	11.6
Passenger Ship	5,000	103	90	15.8	4.0
	7,000	115	101	17.1	4.4
	10,000	130	113	18.6	5.0
	15,000	150	130	20.4	5.7
	20,000	165	143	21.9	7.0
	30,000	190	163	24.0	7.0
	50,000	227	193	31.6	7.0
	70,000	255	216	31.6	8.0
	100,000	288	243	31.6	8.0

・Coverage rate：75%

Type	Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
Cargo Ship	5,000	107	99	17.0	6.4
	7,000	118	110	18.7	7.2
	10,000	132	123	20.7	8.1
	15,000	148	139	23.2	9.2
	20,000	161	152	25.2	10.2
	30,000	182	171	28.3	10.5
	50,000	211	200	32.7	12.4
	70,000	233	222	36.0	13.8
	100,000	259	247	39.8	15.5
	150,000	292	279	44.7	17.7
	200,000	318	305	48.5	19.4
	300,000	358	345	54.5	22.1
Container Ship	5,000	109	101	17.9	6.3
	7,000	123	114	19.8	7.1
	10,000	139	129	22.0	7.9
	15,000	160	149	24.9	9.0
	20,000	177	165	27.1	9.9
	30,000	203	191	30.7	11.2
	50,000	274	258	33.2	12.7
	70,000	286	274	40.9	14.1
	100,000	350	335	42.8	14.7
Oil Tanker	5,000	100	97	16.7	6.3
	7,000	110	109	18.2	6.9
	10,000	139	131	20.6	7.6
	15,000	154	146	23.4	8.6
	20,000	166	157	25.6	9.3
	30,000	184	175	29.1	10.4
	50,000	209	199	34.3	12.0
	70,000	228	217	38.1	12.9
	100,000	250	238	42.7	14.8
	150,000	277	265	48.6	17.2
	200,000	334	321	59.4	19.2
	300,000	334	321	59.4	22.4

Type	Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
Roll-on/ Roll-off	5,000	117	105	20.4	5.5
	7,000	131	119	22.0	6.2
	10,000	149	136	23.9	6.9
	15,000	171	157	26.2	7.9
	20,000	189	175	28.0	8.7
	40,000	194	174	32.3	9.7
	50,000	208	189	32.3	9.7
	60,000	208	189	32.3	9.7
Pure Car Carrier Ship	5,000	104	88	18.0	5.4
	7,000	115	100	19.4	5.9
	10,000	128	115	20.9	6.5
	15,000	145	134	22.9	7.3
	20,000	158	150	24.4	7.9
	30,000	179	175	26.7	8.8
	40,000	185	175	31.9	9.3
	50,000	203	194	32.3	10.4
	60,000	203	194	32.3	10.4
LPG Ship	5,000	116	109	18.6	7.3
	7,000	129	121	20.5	8.0
	10,000	144	136	22.7	8.9
	15,000	164	155	25.5	9.9
	20,000	179	170	27.7	10.8
	30,000	204	193	31.1	12.1
	50,000	240	228	36.0	14.0
	60,000	254	242	37.9	14.7
LNG Ship	5,000	111	103	18.2	6.1
	7,000	123	116	20.2	6.6
	10,000	139	130	22.5	7.2
	15,000	158	149	25.5	7.9
	20,000	174	164	27.8	8.4
	30,000	199	188	31.4	9.2
	50,000	235	223	36.7	10.4
	70,000	262	249	40.7	11.2
	100,000	294	281	45.4	12.1
Passenger Ship	5,000	115	104	18.6	5.1
	7,000	130	117	20.1	5.7
	10,000	146	131	21.8	6.4
	15,000	168	150	24.0	7.3
	20,000	186	165	25.7	7.8
	30,000	214	189	28.2	7.8
	50,000	255	224	32.4	7.8
	70,000	286	250	32.4	8.1
	100,000	324	281	32.4	8.1

・Coverage rate：95%

Type	Dead Weigth Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
Cargo Ship	5,000	118	108	18.5	7.4
	7,000	130	119	20.4	8.3
	10,000	145	133	22.6	9.3
	15,000	163	150	25.4	10.6
	20,000	177	164	27.5	11.7
	30,000	200	186	30.9	11.2
	50,000	232	217	35.8	13.3
	70,000	256	240	39.4	14.8
	100,000	285	268	43.6	16.6
	150,000	321	303	48.9	18.9
	200,000	349	330	53.1	20.8
	300,000	394	373	59.6	23.7
Container Ship	5,000	116	107	18.9	6.7
	7,000	130	121	20.9	7.4
	10,000	147	137	23.3	8.3
	15,000	170	158	26.3	9.5
	20,000	187	175	28.7	10.4
	30,000	216	203	32.4	11.9
	50,000	294	276	34.4	13.2
	70,000	293	281	44.0	14.5
	100,000	361	342	43.2	14.9
Oil Tanker	5,000	108	103	18.8	7.2
	7,000	118	115	20.5	8.0
	10,000	144	135	21.6	8.8
	15,000	159	150	24.6	9.8
	20,000	171	161	26.9	10.7
	30,000	190	179	30.6	11.9
	50,000	216	204	36.0	13.8
	70,000	235	223	40.1	13.8
	100,000	258	244	44.9	15.8
	150,000	286	271	51.0	18.5
	200,000	339	326	61.0	20.6
	300,000	339	326	61.0	24.0

Type	Gross Tonnage (t)	Length Overall (m)	Length P.P. (m)	Breadth Molded (m)	Full Load Draft (m)
Roll-on/ Roll-off	5,000	137	120	24.0	7.0
	7,000	154	136	26.0	7.8
	10,000	174	155	28.2	8.8
	15,000	200	179	30.9	10.0
	20,000	222	199	33.0	11.0
	40,000	204	179	32.3	9.9
	50,000	217	201	32.3	9.9
	60,000	217	201	32.3	9.9
Pure Car Carrier Ship	5,000	119	98	19.0	6.4
	7,000	132	112	20.5	7.0
	10,000	147	128	22.1	7.7
	15,000	166	150	24.2	8.6
	20,000	181	167	25.8	9.3
	30,000	205	196	28.2	10.4
	40,000	192	182	33.4	10.0
	50,000	214	204	32.4	11.2
	60,000	214	204	32.4	11.2
LPG Ship	5,000	123	116	19.9	8.4
	7,000	137	129	21.9	9.3
	10,000	153	145	24.3	10.3
	15,000	174	165	27.3	11.5
	20,000	191	181	29.6	12.5
	30,000	217	206	33.3	14.0
	50,000	255	243	38.5	16.2
	60,000	270	258	40.5	17.1
LNG Ship	5,000	116	108	18.8	6.6
	7,000	130	121	20.8	7.1
	10,000	146	137	23.2	7.7
	15,000	167	156	26.2	8.4
	20,000	183	172	28.6	9.0
	30,000	209	197	32.4	9.9
	50,000	247	234	37.8	11.1
	70,000	275	262	41.9	11.9
	100,000	309	295	46.7	13.0
Passenger Ship	5,000	137	129	23.4	7.2
	7,000	153	144	25.3	8.1
	10,000	173	162	27.5	9.1
	15,000	199	186	30.2	10.4
	20,000	220	204	32.3	8.9
	30,000	253	234	35.6	8.9
	50,000	302	277	33.5	8.9
	70,000	339	309	33.5	8.3
	100,000	383	348	33.5	8.3

7. Conclusion

This report has presented the results of research on ship dimensions and the Standards for the Main Dimensions of Ships (Draft) based on statistical analysis carried out by the Port Planning Division, Port and Harbour Department, National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport in preparation for the revision of the Technical Standards and Commentaries of Port and Harbor Facilities (scheduled for 2006).

The results of this paper differ partially from the results in the Japanese Language Report[2], that contains the results of research applied to revise the Technical Standards and Commentaries of Port and Harbor Facilities (scheduled for 2006) that is the foundation of this report. It differs because the Japanese Language Report, Study on Ship Dimensions by Statistical Analysis (Research Report of National Institute for Land and Infrastructure Management,No.28,2006) partially dealt with ships unique to Japan.

(Received on February 15.2006)

References

1): The Japan Port and Habour Association :Technical Standards and Commentaries of Port and Harbor Facilities ,1999

2) Hironao TAKAHASHI, Ayako GOTO, Motohisa ABE :Study on Ship Dimensions by Statistical Analysis -Standard of Main Dimensions of Design Ship (Draft)-,Research Report of National Institute for Land and Infrastructure Manegement, No.28, 2006.3 (in Japanese)

3)Yasuhiro AKAKURA, Hironao TAKAHASHI:Ship Dimensions of Design Ship under Given Confidence Limits,Technical Note of P.H.R.I. , No.911 , 1998.9

Appendix　A

Table A.1　1)Port and Harbor Engineer

	tonnage	Length (m)	Width (m)	Depth (m)	Fully Loaded Draft (m)	Displacement (t)
Cargo Boats	700	52	8.3	3.8	3.6	900
	1,000	60	9.3	4.4	4.1	1,300
	2,000	77	11.5	5.8	5.1	2,700
	3,000	90	13.1	6.8	5.7	4,000
	4,000	100	14.3	7.7	6.3	5,300
	5,000	109	15.3	8.4	6.7	6,700
	6,000	117	16.2	9.0	7.1	8,000
	7,000	124	17.0	9.6	7.5	9,300
	8,000	130	17.7	10.1	7.8	10,700
	9,000	136	18.4	10.6	8.1	12,000
	10,000	142	19.0	11.1	8.3	13,300
	12,000	152	20.1	11.9	8.8	16,000
	15,000	165	21.6	13.0	9.5	20,000
	17,000	173	22.4	13.7	9.8	22,700
	20,000	184	23.6	14.6	10.3	26,700
Passenger Boats	500	50	8.2	4.5	4.0	500
	1,000	65	10.0	5.3	4.5	1,000
	2,000	82	12.0	6.4	5.2	2,000
	3,000	95	13.5	7.3	5.7	3,000
	4,000	105	14.8	8.0	6.3	4,000
	5,000	113	15.8	8.8	6.8	5,000
	6,000	121	16.7	9.5	7.2	6,000
	7,000	127	17.5	10.2	7.6	7,000
	8,000	135	18.2	10.8	8.0	8,000
	10,000	145	19.2	12.0	8.5	10,000
	15,000	165	21.5	13.0	8.8	15,000
	20,000	180	23.0	13.8	9.0	20,000
	30,000	210	26.5	15.5	9.5	30,000
	50,000	245	30.5	18.0	10.5	50,000
	80,000	290	36.0	21.0	11.7	80,000
Ore Carriers	1,000	61	8.9	4.8	3.3	1,300
	2,000	77	11.1	6.0	5.1	2,700
	3,000	88	12.7	6.8	5.7	4,000
	4,000	96	13.9	7.5	6.1	5,300
	5,000	104	14.9	8.1	6.5	6,700
	15,000	149	21.3	11.5	8.6	20,000
	20,000	164	23.4	12.7	9.2	26,700
	25,000	176	25.1	13.6	9.8	33,300
	30,000	187	26.6	14.4	10.3	40,000
	40,000	206	29.2	15.9	11.0	53,300
	50,000	222	31.4	17.1	11.7	66,700
	60,000	235	33.3	18.1	12.3	80,000
	70,000	248	35.0	19.0	12.8	93,300
	80,000	259	36.6	19.9	13.2	106,700
	100,000	278	39.3	21.4	14.0	133,300
Tankers	300	37	7.0	3.3	3.0	400
	500	43	7.8	3.8	3.5	700
	700	54	7.9	4.0	3.8	900
	1,000	61	8.9	4.5	4.2	1,300
	2,000	76	11.2	5.7	5.1	2,700
	3,000	87	12.8	6.5	5.7	4,000
	4,000	96	14.0	7.2	6.2	5,300
	5,000	103	15.1	7.8	6.5	6,700
	6,000	110	16.0	8.2	6.9	8,000
	7,000	116	16.8	8.7	7.2	9,300
	20,000	164	23.7	12.3	9.5	26,700
	25,000	176	25.5	13.3	10.1	33,300
	30,000	187	27.1	14.1	10.6	40,000
	35,000	197	28.5	14.8	11.1	46,700
	40,000	206	29.7	15.5	11.5	53,300
	50,000	222	32.0	16.7	12.2	66,700
	60,000	236	34.0	17.8	12.8	80,000
	70,000	248	35.7	18.7	13.4	93,300
	80,000	260	37.3	19.6	13.9	106,700
	100,000	280	40.1	21.1	14.8	133,300
	120,000	297	42.6	22.4	15.5	160,000

Table A.2 2)Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 1996

Seagoing Vessels

Passenger Vessels(table R39-1.1)

tonnage	Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft
GT	DWT	t	m	m	m	m
80,000	-	75,000	315	295	35.5	11.5
70,000	-	65,000	315	295	34.0	11.0
60,000	-	55,000	310	290	32.5	10.5
50,000	-	45,000	300	280	31.0	10.5
40,000	-	35,000	265	245	29.5	10.0
30,000	-	30,000	230	210	28.0	10.0

Bulk Carriers(table R39-1.2) (oil, ore, coal, grain, etc.)

tonnage	Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft
GT	DWT	t	m	m	m	m
-	450,000	524,000	424	404	68.5	25.0
-	420,000	490,000	418	398	67.0	24.5
-	380,000	445,000	407	386	64.5	24.0
-	365,000	428,000	404	383	63.5	23.0
-	340,000	400,000	398	378	62.5	23.0
-	300,000	356,000	385	364	59.5	22.0
-	275,000	326,000	376	355	57.5	21.5
-	250,000	300,000	367	346	55.5	20.5
-	225,000	270,000	356	336	53.5	20.5
-	200,000	240,000	345	326	51.0	19.5
-	175,000	212,000	330	315	48.5	18.5
-	150,000	180,000	315	300	46.0	16.5
-	125,000	155,000	295	280	43.5	16.0
-	100,000	125,000	280	265	41.0	15.0
-	85,000	105,000	265	255	38.0	14.0
-	65,000	85,000	255	245	33.5	13.0
-	45,000	60,000	230	220	29.0	11.5
-	35,000	45,000	210	200	27.0	11.0
-	25,000	30,000	190	180	24.5	10.5
-	15,000	20,000	165	155	21.5	9.5

Mixed Cargo Freighters(Full Deck Construction)(table R31-1.3)

tonnage	Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft
GT	DWT	t	m	m	m	m
10,000	15,000	20,000	165	155	21.5	9.5
7,500	11,000	15,000	150	140	20.0	9.0
5,000	7,500	10,000	135	125	17.5	8.0
4,000	6,000	8,000	120	110	16.0	7.5
3,000	4,500	6,000	105	100	14.5	7.0
2,000	3,000	4,000	95	90	13.0	6.0
1,500	2,200	3,000	90	85	12.0	5.5
1,000	1,500	2,000	75	70	10.0	4.5
500	700	1,000	60	55	8.5	3.5

Fishing Vessels(table R39-1.4)

tonnage	Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft
GT	DWT	t	m	m	m	m
2,500	-	2,800	90	80	14.0	5.9
2,000	-	2,500	85	75	13.0	5.6
1,500	-	2,100	80	70	12.0	5.3
1,000	-	1,750	75	65	11.0	5.0
800	-	1,550	70	60	10.5	4.8
600	-	1,200	65	55	10.0	4.5
400	-	800	55	45	8.5	4.0
200	-	400	40	35	7.0	3.5

Container Ships(table R39-1.5)

Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft	Number of containers	Generation
DWT	t	m	m	m	m	circa	
75,000	90,000	350	335	45.0	14.0	6,000	6th
66,300	80,000	275	262	40.0	14.0	4,800	5th
64,500	77,500	294	282	32.2	13.5	4,400	5th
55,000	77,000	275	260	39.4	12.5	3,900	4th
50,000	73,500	290	275	32.4	13.0	2,800	3rd
42,000	61,000	285	270	32.3	12.0	2,380	3rd
36,000	51,000	270	255	31.8	11.7	2,000	3rd
30,000	41,500	228	214	31.0	11.3	1,670	2nd
25,000	34,000	212	198	30.0	10.7	1,380	2nd
20,000	27,000	198	184	28.7	10.0	1,100	2nd
15,000	20,000	180	166	26.5	9.0	810	1st
10,000	13,500	159	144	23.5	8.0	530	1st
7,000	9,600	143	128	19.0	6.5	316	1st

Car transport Ships(table R39-1.6)

Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft	No. of cars
DWT	t	m	m	m	m	approx.
28,000	45,000	198	183	32.3	11.8	6,200
26,300	42,000	213	198	32.3	10.5	6,000
17,900	33,000	195	180	32.2	9.7	5,600

Ferries and Ro-Ro Ships(table R39-1.7)

Carrying capacity	Displace-ment *G*	Overall length	Length between perps	Beam	Draft
DWT	t	m	m	m	m
106,400	115,000	253.00	238.00	40.00	15.10
64,400	76,100	225.00	215.00	34.00	13.00
42,500	53,000	182.50	173.00	32.30	12.00
27,750	39,800	177.30	158.10	27.30	11.55
18,000	32,650	181.20	165.00	30.40	9.30
16,000	23,400	178.10	164.00	26.80	7.60
14,000	21,500	163.80	148.60	23.50	8.80
12,000	20,000	190.90	173.00	26.00	7.18
10,000	23,410	192.50	181.00	27.30	6.75
8,000	16,000	156.00	137.00	22.60	7.30
6,000	20,750	179.40	170.00	27.80	6.27
4,000	17,500	163.40	150.00	27.00	6.20
2,000	10,800	164.70	159.60	17.70	5.90

The data in the vary according to type of load(cars, trucks, trailers, waggons, passengers) and load shares.

Table A.3 3)Approach Channels A Guide for Design 1997.

Tankers (ULCC)

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
500,000	590,000	415.0	392.0	73.0	24.0	0.86
400,000	475,000	380.0	358.0	68.0	23.0	0.85
350,000	420,000	365.0	345.0	65.5	22.0	0.85

Tankers (VLCC)

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
300,000	365,000	350.0	330.0	63.0	21.0	0.84
275,000	335,000	340.0	321.0	61.0	20.5	0.84
250,000	305,000	330.0	312.0	59.0	19.9	0.83
225,000	277,000	320.0	303.0	57.0	19.3	0.83
200,000	246,000	310.0	294.0	55.0	18.5	0.82

Tankers

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
175,000	217,000	300.0	285.0	52.5	17.7	0.82
150,000	186,000	285.0	270.0	49.5	16.9	0.82
125,000	156,000	270.0	255.0	46.5	16.0	0.82
10,000	125,000	250.0	236.0	43.0	15.1	0.82
80,000	102,000	235.0	223.0	40.0	14.0	0.82
70,000	90,000	225.0	213.0	38.0	13.5	0.82
60,000	78,000	217.0	206.0	36.0	13.0	0.81

Product and Chemical Tankers

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
50,000	66,000	210.0	200.0	32.2	12.6	0.81
40,000	54,000	200.0	190.0	30.0	11.8	0.80
30,000	42,000	188.0	178.0	28.0	10.8	0.78
20,000	29,000	174.0	165.0	24.5	9.8	0.73
10,000	15,000	145.0	137.0	19.0	7.8	0.74
5,000	8,000	110.0	104.0	15.0	7.0	0.73
3,000	4,900	90.0	85.0	13.0	6.0	0.74

Bulk Carriers／OBO's

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
400,000	464,000	375.0	356.0	62.5	24.0	0.87
350,000	406,000	362.0	344.0	59.0	23.0	0.87
300,000	350,000	350.0	333.0	56.0	21.8	0.86
250,000	292,000	335.0	318.0	52.5	20.5	0.85
200,000	236,000	315.0	300.0	48.5	19.0	0.85
150,000	179,000	290.0	276.0	44.0	17.5	0.84
125,000	150,000	275.0	262.0	41.5	16.5	0.84
100,000	121,000	255.0	242.0	39.0	15.3	0.84
80,000	98,000	240.0	228.0	36.5	14.0	0.84
60,000	74,000	220.0	210.0	33.5	12.8	0.82
40,000	50,000	195.0	185.0	29.0	11.5	0.80
20,000	26,000	160.0	152.0	23.5	9.3	0.78
10,000	13,000	130.0	124.0	18.0	7.5	0.78

Container Ships(Post Panamax)

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
70,000	100,000	280.0	266.0	41.8	13.8	0.65
65,000	92,000	274.0	260.0	41.2	13.5	0.64
60,000	84,000	268.0	255.0	39.8	13.2	0.63
55,000	76,500	261.0	248.0	38.3	12.8	0.63

Container Ships(Panamax)

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
60,000	83,000	290.0	275.0	32.2	13.2	0.71
55,000	75,500	278.0	264.0	32.2	12.8	0.69
50,000	68,000	267.0	253.0	32.2	12.5	0.67
45,000	61,000	255.0	242.0	32.2	12.2	0.64
40,000	54,000	237.0	225.0	32.2	11.7	0.64
35,000	47,500	222.0	211.0	32.2	11.1	0.63
30,000	40,500	210.0	200.0	30.0	10.7	0.63
25,000	33,500	195.0	185.0	28.5	10.1	0.63
20,000	27,000	174.0	165.0	26.2	9.2	0.68
15,000	20,000	152.0	144.0	23.7	8.5	0.69
10,000	13,500	130.0	124.0	21.2	7.3	0.70

Freight Ro-Ro Ships

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
50,000	87,500	287.0	273.0	32.2	12.4	0.80
45,000	81,000	275.0	261.0	32.2	12.0	0.80
40,000	72,000	260.0	247.0	32.2	11.4	0.79
35,000	63,000	245.0	233.0	32.2	10.8	0.78
30,000	54,000	231.0	219.0	32.0	10.2	0.75
25,000	45,000	216.0	205.0	31.0	9.6	0.75
20,000	36,000	197.0	187.0	28.6	9.1	0.75
15,000	27,500	177.0	168.0	26.2	8.4	0.74
10,000	18,400	153.0	145.0	23.4	7.4	0.73
5,000	9,500	121.0	115.0	19.3	6.0	0.71

Cargo Vessels

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
40,000	54,500	209.0	199.0	30.0	12.5	0.73
35,000	48,000	199.0	189.0	28.9	12.0	0.73
30,000	41,000	188.0	179.0	27.7	11.3	0.73
25,000	34,500	178.0	169.0	26.4	10.7	0.72
20,000	28,000	166.0	158.0	24.8	10.0	0.71
15,000	21,500	152.0	145.0	22.6	9.2	0.71
10,000	14,500	133.0	127.0	19.8	8.0	0.72
5,000	7,500	105.0	100.0	15.8	6.4	0.74
2,500	4,000	85.0	80.0	13.0	5.0	0.77

Vehicle Carries

Dead-weight tonnes	Displacement tonnes	LengthOA m	Lengthpp m	Beam m	Draught m	Block Coefficient
30,000	48,000	210.0	193.0	32.2	11.7	0.66
25,000	42,000	205.0	189.0	32.2	10.9	0.63
20,000	35,500	198.0	182.0	32.2	10.0	0.61
15,000	28,500	190.0	175.0	32.2	9.0	0.56

Ferries

Gross tonnes	Displacement tonnes	LengthOa m	Lengthpp m	Beam m	Draught m	Block Coefficient
50,000	25,000	197.0	183.0	30.6	7.1	0.63
40,000	21,000	187.0	174.0	28.7	6.7	0.63
35,000	19,000	182.0	169.0	27.6	6.5	0.63
30,000	17,000	175.0	163.0	26.5	6.3	0.62
25,000	15,000	170.0	158.0	25.3	6.1	0.62
20,000	13,000	164.0	152.0	24.1	5.9	0.60
15,000	10,500	155.0	144.0	22.7	5.6	0.57

Cruise Liners

Gross tonnes	Displacement tonnes	LengthOa m	Lengthpp m	Beam m	Draught m	Block Coefficient
80,000	44,000	272.0	231.0	35.0	8.0	0.68
70,000	38,000	265.0	225.0	32.2	7.8	0.67
60,000	34,000	252.0	214.0	32.2	7.6	0.65
50,000	29,000	234.0	199.0	32.2	7.1	0.64
40,000	24,000	212.0	180.0	32.2	6.5	0.64
35,000	21,000	192.0	164.0	32.2	6.3	0.63

Table A.4 4)TECHNICAL CODES FOR PORT ENGINEERNIG 2000

Design Ship Dimensions of General Vessel
TableA.0.1-1

Tonnage of ship DWT (t)	Design ship dimension (m) Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*
1000 (1000～1500)	65	11	5.3	4.4
2000 (1501～2500)	75	12	6.8	5.2
3000 (2501～4500)	97	15	7.9	6.1
5000 (4501～7500)	112	17	9.2	7.0
10000 (7501～11500)	153	20	11.8	8.8
15000 (11501～16500)	162	22	13.3	9.8
20000 (16501～22000)	175	24	14.4	10.4

Design Ship Dimensions of Bulk Carriers
TableA.0.1-2

Tonnage of ship DWT (t)	Design ship dimension (m) Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*
10000 (7501～12500)	150	20	11.0	8.5
15000 (12501～17500)	157	21	12.3	9.3
20000 (17501～22500)	170	23	13.4	10.0
30000 (22501～35000)	190	26	14.6	10.8
40000 (35001～45000)	205	29	16.2	11.8
50000 (45001～65000)	230	32	17.5	12.7
70000 (65001～75000)	253	35	19.3	13.8
100000 (75001～105000)	260	39	21.4	15.2
120000 (105001～135000)	269	42	24.2	17.0
150000 (135001～175000)	300	46	25.9	18.1
200000 (175001～225000)	322	50	27.3	19.0

Design Ship Dimensions of Oil Tankers
TableA.0.1-3

Tonnage of ship DWT (t)	Design ship dimension (m) Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*
1000 (1000～1500)	68	10	5.3	4.3
2000 (1501～2500)	75	12	6.8	5.3
3000 (2501～4500)	100	14	7.5	5.7
5000 (4501～7500)	110	15	9.0	6.5
10000 (7501～12500)	150	20	11.4	9.0
20000 (12501～27500)	182	25	13.0	10.0
30000 (27501～45000)	212	29	15.4	11.4
50000 (45001～65000)	235	32	17.4	12.6
80000 (65001～85000)	250	38	19.0	13.6
100000 (85001～105000)	268	39	21.2	15.2
120000 (105001～135000)	279	42	23.1	16.9
150000 (135001～175000)	294	46	24.0	17.7
200000 (175001～225000)	326	50	25.6	19.1
225000 (215001～235000)	329	52	27.2	20.5
250000 (235001～275000)	346	54	27.6	20.8
300000 (275001～375000)	358	56	29.4	22.4

Design Ship Dimensions of Container Ships
TableA.0.1-4

Tonnage of ship DWT (t)	Design ship dimension (m) Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*	Container loaded (TEU)
4000 (1000～5000)	105	16	8.0	5.8	＜200
10000 (5001～12000)	152	22	12.8	8.8	201～500
15000 (12001～17500)	197	25	15.8	9.8	501～900
25000 (17501～27500)	217	30	18.9	10.7	901～1500
30000 (27501～32500)	237	31	20.0	11.5	1501～1800
35000 (32501～37500)	260	32	21.0	12.0	1801～2100
40000 (37501～45000)	270	33	21.2	12.5	2101～3000
50000 (45001～65000)	294	35	21.8	13.3	3001～4800

Design Ship Dimensions of Roll-on/Roll-off Ship
TableA.0.1-5

Tonnage of ship	Design ship dimension (m)			
DWT (t)	Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*
1000 (851～1500)	99	16	10.0	4.4
2000 (1501～2500)	115	17	11.0	5.3
3000 (2501～4500)	130	20	12.8	6.2
5000 (4501～7500)	147	22	14.3	7.1
10000 (7501～12500)	173	28	16.0	8.2
15000 (12501～17500)	194	30	19.4	9.5
20000 (17501～22500)	212	31	21.3	10.2
30000 (22501～35000)	235	32	21.4	11.6

Design Ship Dimensions of Vehicle Carrier
TableA.0.1-6

Tonnage of ship	Design ship dimension (m)				
DWT (t)	Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*	Vehicle loaded (set)
1000 (500～1500)	95	15	10	4.7	＜450
2000 (1501～2500)	109	17	13	5.4	451～700
3000 (2501～4500)	124	20	14	6.5	701～1100
5000 (4501～7500)	152	25	15	7.6	1101～1900
10000 (7501～11500)	176	28	21	8.1	1901～3100
15000 (11501～16500)	194	32	24	9.0	3101～5000
20000 (16501～22500)	200	32	24	9.5	5001～6500

Design Ship Dimensions of Bulk Carrier
TableA.0.1-7

Tonnage of ship	Design ship dimension (m)			
DWT (t)	Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*
1000 (500～1500)	66	11	4.9	4.4
2000 (1501～2500)	78	12	5.9	5.0
3000 (2501～4500)	98	15	7.6	6.2
5000 (4501～7500)	113	16	8.2	6.9
10000 (7501～12500)	133	20	10.1	7.8
15000 (12501～17500)	157	22	12	9.1
20000 (17501～22500)	165	24	13.4	9.7
30000 (22501～35000)	196	24	14.2	10.6
40000 (35501～45000)	188	31	15.7	11.3

Design Ship Dimensions of Liquid Chebical Product and Oil Tankers
TableA.0.1-8

Tonnage of ship	Design ship dimension (m)			
DWT (t)	Overall length *L*	Molded breadth *B*	Molded depth *H*	Loaded draft *T*
1000 (1000～1500)	67	10	5.0	4.3
2000 (1501～2500)	80	12	6.0	5.2
3000 (2501～4500)	98	14	7.5	6.2
5000 (4501～7500)	113	18	8.6	7.1
10000 (7501～12500)	135	20	10.9	8.4
20000 (12501～27500)	172	25	13.5	10.2
30000 (27501～45000)	178	32	15.6	11.6
50000 (45501～65000)	221	32	18.3	13.3

Design Ship Dimensions of Liquid Chebical Product and Oil Tankers
TableA.0.2-1

Tonnage of ship	Length of Overall (m)				Molded breadth (m)				Molded depth (m)			
DWT (t)	Max.	Min.	Mean	Normal	Max.	Min.	Mean	Normal	Max.	Min.	Mean	Normal
4000 (1000～5000)	182	61	93	105	20.3 (8)	10.8 (4)	14.6 (5)	16	11.6	4.0	7.2	8.0
10000 (5001～12000)	190	86	125	152	29.0 (11)	15.0 (6)	19.5 (7)	22	14.6	7.5	9.7	12.8
15000 (12001～17500)	214	137	165	197	32.3 (13)	19.2 (7)	23.7 (9)	25	30.6	10.6	13.6	15.8
25000 (17501～27500)	258	155	193	217	32.2 (13)	20.8 (8)	27.3 (11)	30	18.9	12.0	15.2	18.9.
30000 (27501～32500)	262	173	215	237	32.3 (13)	23.6 (9)	30.2 (12)	31	21.6	14.6	17.3	20.0
35000 (32501～37500)	289	183	225	260	32.3 (13)	26.8 (9)	31.6 (12)	32	23.9	14.7	18.5	21.0
40000 (37501～42500)	297	203	248		32.3 (13)	30.5 (12)	32.0 (13)		24.0	16.4	19.6	
45000 (42501～47500)	292	229	255		32.3 (13)	32.0 (13)	32.2 (13)		24.3	17.4	20.0	
50000 (47501～55000)	294	243	274		39.4 (16)	32.2 (13)	33.2 (13)		24.6	18.8	21.7	
60000 (55001～65000)	297	275	290		39.0 (15)	32.0 (13)	33.3 (13)		21.7	17.4	21.3	

Tonnage of ship	Loaded draft (m)				Loading Capacity (TEU)				Ship statistics
DWT (t)	Max.	Min.	Mean	Normal	Max.	Min.	Mean	Normal	(vessel)
4000 (1000～5000)	7.2	3.4	5.2	5.8	583	48	177	-	118
10000 (5001～12000)	9.9	5.3	7.1	8.8	918	124	418	-	207
15000 (12001～17500)	10.5	7.9	9.0	9.8	1174	398	774	-	158
25000 (17501～27500)	11.6	7.9	10.2	10.7	2708	322	1200	-	217
30000 (27501～32500)	11.8	9.7	11.1	11.5	2500	1027	1681	-	110
35000 (32501～37500)	12.0	10.6	11.5	12.0	2670	1140	1928	-	63
40000 (37501～42500)	12.5	10.4	11.6		3161	1700	2507	-	63
45000 (42501～47500)	13.0	11.2	12.0		3800	2228	3046	-	78
50000 (47501～55000)	13.2	11.6	12.6		4425	2052	3306	-	68
60000 (55001～65000)	13.6	11.7	12.9		4800	3600	4143	-	94

Ship's Dimensions of Typical Roll-on/Roll-off Ships
TableA.0.2-2

Ship's DWT	Length of Overall (m)			Molded breadth (m)			Molded depth (m)			Loaded draft (m)			Ship statistics
(t)	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	(vessel)
1000 (851～1500)	148	64	87	23.5	10.5	14.2	14.9	4.4	8.2	6.8	2.9	4.1	62
2000 (1501～2500)	156	73	95	22.0	10.5	15.4	16.3	4.0	8.5	6.0	3.4	4.6	107
3000 (2501～4500)	199	81	112	27.0	13.0	17.8	19.3	3.7	10.4	6.9	3.6	5.5	254
5000 (4501～7500)	190	99	132	32.2	15.0	19.8	17.4	6.1	12.1	7.7	4.5	6.4	225
10000 (7501～12500)	199	118	154	32.2	18.0	23.2	27.4	7.0	13.8	9.5	4.9	7.5	140
15000 (12501～17500)	241	133	178	32.3	19.4	27.8	32.4	9.0	16.4	13.3	7.4	9.0	122
20000 (17501～22500)	252	156	194	32.3	20.0	27.7	32.1	11.3	17.4	11.1	8.2	9.7	100
30000 (22501～35000)	288	175	216	32.5	26.0	31.6	31.5	12.3	19.8	11.9	7.5	10.8	65

Ship's Dimensions of Typical Bulk Cement Carrier
TableA.0.2-3

Ship's DWT	Length of Overall (m)			Molded breadth (m)			Molded depth (m)			Loaded draft (m)			Ship statistics
(t)	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	(vessel)
1000 (1000～1500)	73	45	62	16.2	9.0	10.6	6.0	4.1	4.7	4.9	3.4	4.1	39
2000 (1501～2500)	91	63	73	14.0	9.0	11.8	6.8	4.7	5.6	5.2	3.5	4.8	36
3000 (2501～4500)	103	75	89	17.0	12.3	14.1	8.1	5.7	6.9	6.9	4.0	5.7	52
5000 (4501～7500)	134	87	108	23.4	14.3	16.1	11.2	5.4	8.2	7.3	3.1	6.6	84
10000 (7501～12500)	149	111	124	20.0	16.5	18.4	11.0	8.3	9.6	8.3	6.7	7.4	34R

Table A.5 5)OBRAS MARIIMAS TECNOLOGIA

Petroleros para crudo

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
500,000	590,000	415.0	392.0	73.0	30.5	24.0	0.86
400,000	475,000	380.0	358.0	68.0	29.2	23.0	0.85
350,000	420,000	365.0	345.0	65.5	28.0	22.0	0.85
300,000	365,000	350.0	330.0	63.0	27.0	21.0	0.84
275,000	335,000	340.0	321.0	31.0	26.3	20.5	0.84
250,000	305,000	330.0	312.0	59.0	25.5	19.9	0.83
225,000	277,000	320.0	303.0	57.0	24.8	19.3	0.83
200,000	246,000	310.0	294.0	55.0	24.0	18.5	0.82
175,000	217,000	300.0	285.0	52.5	23.0	17.7	0.82
150,000	186,000	285.0	270.0	49.5	22.0	16.9	0.82
125,000	156,000	270.0	255.0	46.5	21.0	16.0	0.82
100,000	125,000	250.0	236.0	43.0	19.8	15.1	0.82
80,000	102,000	235.0	223.0	40.0	18.7	14.0	0.82
70,000	90,000	225.0	213.0	38.0	18.2	13.5	0.82
60,000	78,000	217.0	206.0	36.0	17.0	13.0	0.81

Transportadores de productos petroliferos y quimicos

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
50,000	66,000	210.0	200.0	32.2	16.4	12.6	0.81
40,000	54,000	200.0	190.0	30.0	15.4	11.8	0.80
30,000	42,000	188.0	178.0	28.0	14.2	10.8	0.78
20,000	29,000	174.0	165.0	24.5	12.6	9.8	0.73
10,000	15,000	145.0	137.0	19.0	10.0	7.8	0.74
5,000	8,000	110.0	104.0	15.0	8.6	7.0	0.73
3,000	4,900	90.0	85.0	13.0	7.2	6.0	0.74

Graneleros y Polivalentes

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
400,000	464,000	375.0	356.0	62.5	30.6	24.0	0.87
350,000	406,000	362.0	344.0	59.0	29.3	23.0	0.87
300,000	350,000	350.0	333.0	56.0	28.1	21.8	0.86
250,000	292,000	335.0	318.0	52.5	26.5	20.5	0.85
200,000	236,000	315.0	300.0	48.5	25.0	19.0	0.85
150,000	179,000	290.0	276.0	44.0	23.3	17.5	0.84
125,000	150,000	275.0	262.0	41.5	22.1	16.5	0.84
100,000	121,000	255.0	242.0	39.0	20.8	15.3	0.84
80,000	98,000	240.0	228.0	36.5	19.4	14.0	0.84
60,000	74,000	220.0	210.0	33.5	18.2	12.8	0.82
40,000	50,000	195.0	185.0	29.0	16.3	11.5	0.80
20,000	26,000	160.0	152.0	23.5	12.6	9.3	0.78
10,000	13,000	130.0	124.0	18.0	10.0	7.5	0.78

Metaneros

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
60,000	88,000	290.0	275.0	44.5	26.1	11.3	0.64
40,000	59,000	252.0	237.0	38.2	22.3	10.5	0.62
20,000	31,000	209.0	199.0	30.0	17.8	9.7	0.54

Transportadores de Gases Licuados

Tonelaje de Peso Muerto (TPM)	Desplaza-miento(△)	Eslora Total(L)	Eslora entre perpendiculares (Lpp)	Manga (B)	Puntal (T)	Calado (D)	Coeficiente de Bloque
t	t	m	m	m	m	m	
60,000	95,000	265.0	245.0	42.2	23.7	13.5	0.68
50,000	80,000	248.0	238.0	39.0	23.0	12.9	0.67
40,000	65,000	240.0	230.0	35.2	20.8	12.3	0.65
30,000	49,000	226.0	216.0	32.4	19.9	11.2	0.62
20,000	33,000	207.0	197.0	26.8	18.4	10.6	0.59
10,000	17,000	160.0	152.0	21.1	15.2	9.3	0.57
5,000	8,800	134.0	126.0	16.0	12.5	8.1	0.54
3,000	5,500	116.0	110.0	13.3	10.1	7.0	0.54

Portacontenedores(Post Panamax)

Tonelaje de Peso Muerto (TPM)	Desplaza-miento(△)	Eslora Total(L)	Eslora entre perpendiculares (Lpp)	Manga (B)	Puntal (T)	Calado (D)	Coeficiente de Bloque
t	t	m	m	m	m	m	
70,000	100,000	280.0	266.0	41.8	23.6	13.8	0.65
65,000	92,000	274.0	260.0	41.2	23.2	13.5	0.64
60,000	84,000	268.0	255.0	39.8	22.8	13.2	0.63
55,000	76,500	261.0	248.0	38.3	22.4	12.8	0.63

Portacontenedores

Tonelaje de Peso Muerto (TPM)	Desplaza-miento(△)	Eslora Total(L)	Eslora entre perpendiculares (Lpp)	Manga (B)	Puntal (T)	Calado (D)	Coeficiente de Bloque
t	t	m	m	m	m	m	
60,000	83,000	290.0	275.0	32.2	22.8	13.2	0.71
55,000	75,500	278.0	264.0	32.2	22.4	12.8	0.69
50,000	68,000	267.0	253.0	32.2	22.1	12.5	0.67
45,000	61,000	255.0	242.0	32.2	21.4	12.2	0.64
40,000	54,000	237.0	225.0	32.2	20.4	11.7	0.64
35,000	47,500	222.0	211.0	32.2	19.3	11.1	0.63
30,000	40,500	210.0	200.0	30.0	18.5	10.7	0.63
25,000	33,500	195.0	185.0	28.5	17.5	10.1	0.63
20,000	27,000	174.0	165.0	26.2	16.2	9.2	0.68
15,000	20,000	152.0	144.0	23.7	15.0	8.5	0.69
10,000	13,500	130.0	124.0	21.2	13.3	7.3	0.70

Ro-Ro

Tonelaje de Peso Muerto (TPM)	Desplaza-miento(△)	Eslora Total(L)	Eslora entre perpendiculares (Lpp)	Manga (B)	Puntal (T)	Calado (D)	Coeficiente de Bloque
t	t	m	m	m	m	m	
50,000	87,500	287.0	273.0	32.2	28.5	12.4	0.80
45,000	81,500	275.0	261.0	32.2	27.6	12.0	0.80
40,000	72,000	260.0	247.0	32.2	26.2	11.4	0.79
35,000	63,000	245.0	233.0	32.2	24.8	10.8	0.78
30,000	54,000	231.0	219.0	32.0	23.5	10.2	0.75
25,000	45,000	216.0	205.0	31.0	22.0	9.6	0.75
20,000	36,000	197.0	187.0	28.6	21.0	9.1	0.75
15,000	27,500	177.0	168.0	26.2	19.2	8.4	0.74
10,000	18,400	153.0	145.0	23.4	17.0	7.4	0.73
5,000	9,500	121.0	115.0	19.3	13.8	6.0	0.71

Mercantes de Carga Genera

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
40,000	54,500	209.0	199.0	30.0	18.0	12.5	0.73
35,000	48,000	199.0	189.0	28.9	17.0	12.0	0.73
30,000	41,000	188.0	179.0	27.7	16.0	11.3	0.73
25,000	34,500	178.0	169.0	26.4	15.4	10.7	0.72
20,000	28,000	166.0	158.0	24.8	13.8	10.0	0.71
15,000	21,500	152.0	145.0	22.6	12.8	9.2	0.71
10,000	14,500	133.0	127.0	19.8	11.2	8.0	0.72
5,000	7,500	105.0	100.0	15.8	8.5	5.4	0.74
2,500	4,000	85.0	80.0	13.0	6.8	5.0	0.77

Transportadores de coches

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
30,000	48,000	210.0	193.0	32.2	31.2	11.7	0.66
25,000	42,000	205.0	189.0	32.2	29.4	10.9	0.63
20,000	35,500	198.0	182.0	32.2	27.5	10.0	0.61
15,000	28,500	190.0	175.0	32.2	25.5	9.0	0.56

Buques de Guerra

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
16000(1)	20,000	172.0	163.0	23.0	-	8.2	0.65
15000(2)	19,000	195.0	185.0	24.0	-	9.0	0.48
5000(3)	5,700	117.0	115.0	16.8	-	3.7	0.80
4000(4)	7,000	134.0	127.0	14.3	-	7.9	0.49
3500(5)	4,600	120.0	115.0	12.5	-	5.5	0.58
1500(6)	2,100	90.0	85.0	9.3	-	5.2	0.51
1500(7)	1,800	68.0	67.0	6.8	-	5.4	0.73
1400(8)	1,800	89.0	85.0	10.5	-	3.5	0.58
750(9)	1,000	52.0	49.0	10.4	-	4.2	0.47
400(10)	500	58.0	55.1	7.6	-	2.6	0.46

Transbortadores Ferries(convencionales)

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
50,000	25,000	197.0	183.0	30.6	16.5	7.1	0.63
40,000	21,000	187.0	174.0	28.7	15.7.	6.7	0.63
35,000	19,000	182.0	169.0	27.6	15.3	6.5	0.63
30,000	17,000	175.0	163.0	26.5	14.9	6.3	0.62
25,000	15,000	170.0	158.0	25.3	14.5	6.1	0.62
20,000	13,000	164.0	152.0	24.1	14.1	5.9	0.60
15,000	10,500	155.0	144.0	22.7	13.6	5.6	0.57

TABLA 3.1. (Continuacion)

Transbordadores Rapidos, Fast Ferries(valores provisionales)

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
Catamaran							
4,000	640	83.0	73.0	23.2(1)	4.0	2.0(3)	0.43(4)
5,000	800	88.0	78.0	24.7(1)	4.2	2.1(3)	0.44(4)
6,000	960	95.0	84.0	26.6(1)	4.4	2.2(3)	0.44(4)
Monocasco							
8,000	1,280	102.0	87.5	15.4(2)	5.0	2.5(3)	0.45
10,000	1,600	112.0	102.0	16.9(2)	5.2	2.5(3)	0.45
15,000	2,400	128.0	120.0	19.2(2)	5.4	2.7(3)	0.47
20,000	3,200	140.0	133.0	21.0(2)	5.8	2.9(3)	0.49

Cruceros de pasaje

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
80,000	44,000	272.0	231.0	35.0	20.0	8.0	0.68
70,000	38,000	265.0	225.0	32.2	19.3	7.8	0.67
60,000	34,000	252.0	214.0	32.2	18.8	7.6	0.65
50,000	29,000	234.0	199.0	32.2	18.0	7.1	0.64
40,000	24,000	212.0	180.0	32.2	17.3	6.5	0.64
35,000	21,000	192.0	164.0	32.2	17.0	6.3	0.63

Pesqueros

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
3,000	4,200	90.0	85.0	14.0	6.8	5.9	0.60
2,500	3,500	85.0	81.0	13.0	6.4	5.6	0.59
2,000	2,700	80.0	76.0	12.0	6.0	5.3	0.56
1,500	2,200	76.0	72.0	11.3	5.8	5.1	0.53
1,200	1,900	72.0	68.0	11.0	5.7	5.0	0.50
1,000	1,600	70.0	66.0	10.5	5.4	4.8	0.48
700	1,250	65.0	62.0	10.0	5.1	4.5	0.45
500	800	55.0	53.0	8.6	4.5	4.0	0.44
250	400	40.0	38.0	7.0	4.0	3.5	0.43

Embarcaciones deportivas(a motor)

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
-	50.0	24.0	-	5.5	-	3.3	-
-	35.0	21.0	-	4.0	-	3.0	-
-	27.0	18.0	-	4.4	-	27.0	-
-	16.5	15.0	-	4.0	-	2.3	-
-	6.5	12.0	-	3.4	-	1.8	-
-	4.5	9.0	-	2.7	-	1.5	-
-	1.3	6.0	-	2.1	-	1.0	-

Embarcaciones deportivas(a vela)

Tonelaje de Peso Muerto (TPM) t	Desplaza-miento(△) t	Eslora Total(L) m	Eslora entre perpendiculares (Lpp) m	Manga (B) m	Puntal (T) m	Calado (D) m	Coeficiente de Bloque
-	60.0	24.0	-	4.6	-	3.6	-
-	40.0	21.0	-	4.3	-	3.0	-
-	22.0	18.0	-	4.0	-	2.7	-
-	13.0	15.0	-	3.7	-	2.4	-
-	10.0	12.0	-	3.5	-	2.1	-
-	3.5	9.0	-	3.3	-	1.8	-
-	1.5	6.0	-	2.4	-	1.5	-

Table A.6 6)Guidelines for the Design of Fenders Systems:2002(Marcom Report of WG33 2002) ①

Appendix C. Table C-1 — Confidence Limit : 50%

Type	Deadweight tonnage (t)	Displa-cement (t)	Length Overall (m)	Length P.P. (m)	Breadth (m)	Depth (m)	Maximum Draft (m)	Wind Lateral Area(m^2) Full Load Condition	Wind Lateral Area(m^2) Ballast Condition	Wind Front Area(m^2) Full Load Condition	Wind Front Area(m^2) Ballast Condition
General Cargo Ship	1,000	1,580	63	58	10.3	5.2	3.6	227	292	59	88
	2,000	3,040	78	72	12.4	6.4	4.5	348	463	94	134
	3,000	4,460	88	82	13.9	7.2	5.1	447	605	123	172
	5,000	7,210	104	96	16.0	8.4	6.1	612	849	173	236
	7,000	9,900	115	107	17.6	9.3	6.8	754	1,060	216	290
	10,000	13,900	128	120	19.5	10.3	7.6	940	1,340	274	361
	15,000	20,300	146	136	21.8	11.7	8.7	1,210	1,760	359	463
	20,000	26,600	159	149	23.6	12.7	9.6	1,440	2,130	435	552
	30,000	39,000	181	170	26.4	14.4	10.9	1,850	2,780	569	709
	40,000	51,100	197	186	28.6	15.7	12.0	2,210	3,370	690	846
Bulk Carrier	5,000	6,740	106	98	15.0	8.4	6.1	615	850	205	231
	7,000	9,270	116	108	16.6	9.3	6.7	710	1,010	232	271
	10,000	13,000	129	120	18.5	10.4	7.5	830	1,230	264	320
	15,000	19,100	145	135	21.0	11.7	8.4	980	1,520	307	387
	20,000	25,000	157	148	23.0	12.8	9.2	1,110	1,770	341	443
	30,000	36,700	176	167	26.1	14.4	10.3	1,320	2,190	397	536
	50,000	59,600	204	194	32.3	16.8	12.0	1,640	2,870	479	682
	70,000	81,900	224	215	32.3	18.6	13.3	1,890	3,440	542	798
	100,000	115,000	248	239	37.9	20.7	14.8	2,200	4,150	619	940
	150,000	168,000	279	270	43.0	23.3	16.7	2,610	5,140	719	1,140
	200,000	221,000	303	294	47.0	25.4	18.2	2,950	5,990	800	1,310
	250,000	273,000	322	314	50.4	27.2	19.4	3,240	6,740	868	1,450
Container Ship	7,000	10,200	116	108	19.6	9.3	6.9	1,320	1,360	300	396
	10,000	14,300	134	125	21.6	10.7	7.7	1,690	1,700	373	477
	15,000	21,100	157	147	24.1	12.6	8.7	2,250	2,190	478	591
	20,000	27,800	176	165	26.1	14.1	9.5	2,750	2,620	269	687
	25,000	34,300	192	180	27.7	15.4	10.2	3,220	3,010	652	770
	30,000	40,800	206	194	29.1	16.5	10.7	3,660	3,370	729	850
	40,000	53,700	231	218	32.3	18.5	11.7	4,480	4,040	870	990
	50,000	66,500	252	238	32.3	20.2	12.5	5,230	4,640	990	1,110
	60,000	79,100	271	256	35.2	21.7	13.2	5,950	5,200	1,110	1,220
Oil Tanker	1,000	1,450	59	54	9.7	4.3	3.8	170	266	78	80
	2,000	2,810	73	68	12.1	5.4	4.7	251	401	108	117
	3,000	4,140	83	77	13.7	6.3	5.3	315	509	131	146
	5,000	6,740	97	91	16.0	7.5	6.1	419	689	167	194
	7,000	9,300	108	102	17.8	8.4	6.7	505	841	196	233
	10,000	13,100	121	114	19.9	9.5	7.5	617	1,040	232	284
	15,000	19,200	138	130	22.5	11.0	8.4	770	1,320	281	355
	20,000	25,300	151	143	24.6	12.2	9.1	910	1,560	322	416
	30,000	37,300	171	163	27.9	14.0	10.3	1,140	1,990	390	520
	50,000	60,800	201	192	32.3	16.8	11.9	1,510	2,690	497	689
	70,000	83,900	224	214	36.3	18.9	13.2	1,830	3,280	583	829
	100,000	118,000	250	240	40.6	21.4	14.6	2,230	4,050	690	1,010
	150,000	174,000	284	273	46.0	24.7	16.4	2,800	5,150	840	1,260
	200,000	229,000	311	300	50.3	27.3	17.9	3,290	6,110	960	1,480
	300,000	337,000	354	342	57.0	31.5	20.1	4,120	7,770	1,160	1,850
Ro-Ro Ship	1,000	1,970	66	60	13.2	5.2	3.2	700	810	216	217
	2,000	3,730	85	78	15.6	7.0	4.1	970	1,110	292	301
	3,000	5,430	99	90	17.2	8.4	4.8	1,170	1,340	348	364
	5,000	8,710	119	109	19.5	10.5	5.8	1,480	1,690	435	464
	7,000	11,900	135	123	21.2	12.1	6.6	1,730	1,970	503	544
	10,000	16,500	153	141	23.1	14.2	7.5	2,040	2,320	587	643
	15,000	24,000	178	163	25.6	16.9	8.7	2,460	2,790	701	779
	20,000	31,300	198	182	27.4	19.2	9.7	2,810	3,180	794	890
	30,000	45,600	229	211	30.3	23.0	11.3	3,400	3,820	950	1,080

Type	Deadweight tonnage	Displa-cement	Length Overall	Length P.P.	Breadth	Depth	Maximum Draft	Wind Lateral Area(m^2)		Wind Front Area(m^2)	
								Full Load Condition	Ballast Condition	Full Load Condition	Ballast Condition
	(t)	(t)	(m)	(m)	(m)	(m)	(m)				
Passenger Ship	1,000	850	60	54	11.4	4.1	1.9	426	452	167	175
	2,000	1,580	76	68	13.6	5.3	2.5	683	717	225	234
	3,000	2,270	87	78	15.1	6.2	3.0	900	940	267	277
	5,000	3,580	104	92	17.1	7.5	3.6	1,270	1,320	332	344
	7,000	4,830	117	103	18.6	8.6	4.1	1,600	1,650	383	396
	10,000	6,640	133	116	20.4	9.8	4.8	2,040	2,090	446	459
	15,000	9,530	153	132	22.5	11.5	5.6	2,690	2,740	530	545
	20,000	12,300	169	146	24.2	12.8	7.6	3,270	3,320	599	614
	30,000	17,700	194	166	26.8	14.9	7.6	4,310	4,350	712	728
	50,000	27,900	231	197	30.5	18.2	7.6	6,090	6,120	880	900
	70,000	37,600	260	220	33.1	20.7	7.6	7,660	7,660	1,020	1,040
Ferry	1,000	810	59	54	12.7	4.6	2.7	387	404	141	145
	2,000	1,600	76	69	15.1	5.8	3.3	617	646	196	203
	3,000	2,390	88	80	16.7	6.5	3.7	811	851	237	247
	5,000	3,940	106	97	19.0	7.6	4.3	1,150	1,200	302	316
	7,000	5,480	119	110	20.6	8.5	4.8	1,440	1,510	354	372
	10,000	7,770	135	125	22.6	9.5	5.3	1,830	1,930	419	442
	15,000	11,600	157	145	25.0	10.7	6.0	2,400	2,540	508	537
	20,000	15,300	174	162	26.8	11.7	6.5	2,920	3,090	582	618
	30,000	22,800	201	188	29.7	13.3	7.4	3,830	4,070	705	752
	40,000	30,300	223	209	31.9	14.5	8.0	4,660	4,940	810	860
Gas Carrier	1,000	2,210	68	63	11.1	5.3	4.3	350	436	121	139
	2,000	4,080	84	78	13.7	6.8	5.2	535	662	177	203
	3,000	5,830	95	89	15.4	7.8	5.8	686	846	222	254
	5,000	9,100	112	104	17.9	9.4	6.7	940	1,150	295	335
	7,000	12,300	124	116	19.8	10.6	7.4	1,150	1,410	355	403
	10,000	16,900	138	130	22.0	12.0	8.2	1,430	1,750	432	490
	15,000	24,100	157	147	24.8	13.9	9.3	1,840	2,240	541	612
	20,000	31,100	171	161	27.1	15.4	10.0	2,190	2,660	634	716
	30,000	44,400	194	183	30.5	17.8	11.7	2,810	3,400	794	894
	50,000	69,700	227	216	35.5	21.3	11.7	3,850	4,630	1,050	1,180
	70,000	94,000	252	240	39.3	24.0	11.7	4,730	5,670	1,270	1,420
	100,000	128,000	282	268	43.7	27.3	11.7	5,880	7,030	1,550	1,730

Table A.7 6)Guidelines for the Design of Fenders Systems:2002(Marcom Report of WG33 2002) ②

Appendix C. Table C-1 — Confidence Limit : 75%

Type	Deadweight tonnage (t)	Displa-cement (t)	Length Overall (m)	Length P.P. (m)	Breadth (m)	Depth (m)	Maximum Draft (m)	Wind Lateral Area(m^2) Full Load Condition	Wind Lateral Area(m^2) Ballast Condition	Wind Front Area(m^2) Full Load Condition	Wind Front Area(m^2) Ballast Condition
General Cargo Ship	1,000	1,690	67	62	10.8	5.8	3.9	278	342	63	93
	2,000	3,250	83	77	13.1	7.2	4.9	426	541	101	142
	3,000	4,750	95	88	14.7	8.1	5.6	547	408	132	182
	5,000	7,690	111	104	16.9	9.4	6.6	750	993	185	249
	7,000	10,600	123	115	18.6	10.4	7.4	922	1,240	232	307
	10,000	14,800	137	129	20.5	11.6	8.3	1,150	1,570	294	382
	15,000	21,600	156	147	23.0	13.1	9.5	1,480	2,060	385	490
	20,000	28,400	170	161	24.9	14.3	10.4	1,760	2,490	466	585
	30,000	41,600	193	183	27.8	16.2	11.9	2,260	3,250	611	750
	40,000	54,500	211	200	30.2	17.6	13.0	2,700	3,940	740	895
Bulk Carrier	5,000	6,920	109	101	15.5	8.6	6.2	689	910	221	245
	7,000	9,520	120	111	17.2	9.5	6.9	795	1,090	250	287
	10,000	13,300	132	124	19.2	10.6	7.7	930	1,320	286	340
	15,000	19,600	149	140	21.8	11.9	8.6	1,100	1,630	332	411
	20,000	25,700	161	152	23.8	13.0	9.4	1,240	1,900	369	470
	30,000	37,700	181	172	27.0	14.7	10.6	1,480	2,360	428	569
	50,000	61,100	209	200	32.3	17.1	12.4	1,830	3,090	518	723
	70,000	84,000	231	221	32.3	18.9	13.7	2,110	3,690	586	846
	100,000	118,000	255	246	39.2	21.1	15.2	2,460	4,460	669	1,000
	150,000	173,000	287	278	44.5	23.8	17.1	2,920	5,520	777	1,210
	200,000	227,000	311	303	48.7	25.9	18.6	3,300	6,430	864	1,380
	250,000	280,000	332	324	52.2	27.7	19.9	3,630	7,240	938	1,540
Container Ship	7,000	10,700	123	115	20.3	9.8	7.2	1,460	1,590	330	444
	10,000	15,100	141	132	22.4	11.3	8.0	1,880	1,990	410	535
	15,000	22,200	166	156	25.0	13.3	9.0	2,490	2,560	524	663
	20,000	29,200	186	175	27.1	14.9	9.9	3,050	3,070	625	771
	25,000	36,100	203	191	28.8	16.3	10.6	3,570	3,520	716	870
	30,000	43,000	218	205	30.2	17.5	11.1	4,060	3,950	800	950
	40,000	56,500	244	231	32.3	19.6	12.2	4,970	4,730	950	1,110
	50,000	69,900	266	252	32.3	21.4	13.0	5,810	5,430	1,090	1,250
	60,000	83,200	286	271	36.5	23.0	13.8	6,610	6,090	1,220	1,370
Oil Tanker	1,000	1,580	61	58	10.2	4.5	4.0	190	280	86	85
	2,000	3,070	76	72	12.6	5.7	4.9	280	422	119	125
	3,000	4,520	87	82	14.3	6.6	5.5	351	536	144	156
	5,000	7,360	102	97	16.8	7.9	6.4	467	726	184	207
	7,000	10,200	114	108	18.6	8.9	7.1	564	885	216	249
	10,000	14,300	127	121	20.8	10.0	7.9	688	1,090	255	303
	15,000	21,000	144	138	23.6	11.6	8.9	860	1,390	309	378
	20,000	27,700	158	151	25.8	12.8	9.6	1,010	1,650	355	443
	30,000	40,800	180	173	29.2	14.8	10.9	1,270	2,090	430	554
	50,000	66,400	211	204	32.3	17.6	12.6	1,690	2,830	548	734
	70,000	91,600	235	227	38.0	19.9	13.9	2,040	3,460	642	884
	100,000	129,000	263	254	42.5	22.5	15.4	2,490	4,270	761	1,080
	150,000	190,000	298	290	48.1	25.9	17.4	3,120	5,430	920	1,340
	200,000	250,000	327	318	52.6	28.7	18.9	3,670	6,430	1,060	1,570
	300,000	368,000	371	363	59.7	33.1	21.2	4,600	8,180	1,280	1,970
Ro-Ro Ship	1,000	2,190	73	66	14.0	6.2	3.5	880	970	232	232
	2,000	4,150	94	86	16.6	8.4	4.5	120	1,320	314	323
	3,000	6,030	109	99	18.3	10.0	5.3	1,460	1,590	374	391
	5,000	9,670	131	120	20.7	12.5	6.4	1,850	2,010	467	497
	7,000	13,200	148	136	22.5	14.5	7.2	2,170	2,350	541	583
	10,000	18,300	169	155	24.6	17.0	8.2	2,560	2,760	632	690
	15,000	26,700	196	180	27.2	20.3	9.6	3,090	3,320	754	836
	20,000	34,800	218	201	29.1	23.1	10.7	3,530	3,780	854	960
	30,000	50,600	252	233	32.2	27.6	12.4	4,260	4,550	1,020	1,160

Type	Deadweight tonnage	Displa-cement	Length Overall	Length P.P.	Breadth	Depth	Maximum Draft	Wind Lateral Area(m^2)		Wind Front Area(m^2)	
								Full Load Condition	Ballast Condition	Full Load Condition	Ballast Condition
	(t)	(t)	(m)	(m)	(m)	(m)	(m)				
Passenger Ship	1,000	1,030	64	60	12.1	4.9	2.6	464	486	187	197
	2,000	1,910	81	75	14.4	6.3	3.4	744	770	251	263
	3,000	2,740	93	86	16.0	7.4	4.0	980	1,010	298	311
	5,000	4,320	112	102	18.2	9.0	4.8	1,390	1,420	371	386
	7,000	5,830	125	114	19.8	10.2	5.5	1,740	1,780	428	444
	10,000	8,010	142	128	21.6	11.7	6.4	2,220	2,250	498	516
	15,000	11,500	163	146	23.9	13.7	7.5	2,930	2,950	592	611
	20,000	14,900	180	160	25.7	15.3	8.0	3,560	3,570	669	690
	30,000	21,300	207	183	28.4	17.8	8.0	4,690	4,680	795	818
	50,000	33,600	248	217	32.3	21.7	8.0	6,640	6,580	990	1,010
	70,000	45,300	278	243	35.2	24.6	8.0	8,350	8,230	1,140	1,170
Ferry	1,000	1,230	67	61	14.3	5.5	3.4	411	428	154	158
	2,000	2,430	86	78	17.0	6.8	4.2	656	685	214	221
	3,000	3,620	99	91	18.8	7.7	4.8	862	903	259	269
	5,000	5,970	119	110	21.4	9.0	5.5	1,220	1,280	330	344
	7,000	8,310	134	124	23.2	10.0	6.1	1,530	1,600	387	405
	10,000	11,800	153	142	25.4	11.1	6.8	1,940	2,040	458	482
	15,000	17,500	177	164	28.1	12.6	7.6	2,550	2,690	555	586
	20,000	23,300	196	183	30.2	13.8	8.3	3,100	3,270	636	673
	30,000	34,600	227	212	33.4	15.6	9.4	4,070	4,310	771	819
	40,000	45,900	252	236	35.9	17.1	10.2	4,950	5,240	880	940
Gas Carrier	1,000	2,480	71	66	11.7	5.7	4.6	390	465	133	150
	2,000	4,560	88	82	14.3	7.2	5.7	597	707	195	219
	3,000	6,530	100	93	16.1	8.4	6.4	465	903	244	273
	5,000	10,200	117	109	18.8	10.0	7.4	1,050	1,230	323	361
	7,000	13,800	129	121	20.8	11.3	8.1	1,290	1,510	389	434
	10,000	18,900	144	136	23.1	12.9	9.0	1,600	1,870	474	527
	15,000	27,000	164	154	26.0	14.9	10.1	2,050	2,390	593	658
	20,000	34,800	179	169	28.4	16.5	11.0	2,450	2,840	696	770
	30,000	49,700	203	192	32.0	19.0	12.3	3,140	3,630	870	961
	50,000	78,000	237	226	37.2	22.8	12.3	4,290	4,940	1,150	1,270
	70,000	105,000	263	251	41.2	25.7	12.3	5,270	6,050	1,390	1,530
	100,000	144,000	294	281	45.8	29.2	12.3	6,560	7,510	1,690	1,860

Table A.8 6)Guidelines for the Design of Fenders Systems:2002(Marcom Report of WG33 2002) ③

Appendix C. Table C-2 VESSEL DISPLACEMENTS. Confidence Limits: 50%,75%,95%

Type	Deadweight tonnage (t)	Displacement (t)			Type	Deadweight tonnage (t)	Displacement (t)		
		50%	75%	95%			50%	75%	95%
General Cargo Ship	1,000	1,850	1690	1850	Ro-Ro Ship	1,000	1,970	2,170	2,540
	2,000	3,040	3250	3560		2,000	3,730	4,150	4,820
	3,000	4,460	4750	5210		3,000	5,430	6,030	7,010
	5,000	7,210	7690	8440		5,000	8,710	9,670	11,200
	7,000	9,900	10600	11600		7,000	11,900	13,200	15,300
	10,000	13,900	14800	16200		10,000	16,500	18,300	21,300
	15,000	20,300	21600	23700		15,000	24,000	2,700	31,000
	20,000	26,600	28400	31000		20,000	31,300	34,800	41,400
	30,000	39,000	41600	45600		30,000	45,600	50,600	58,800
	40,000	51,100	54500	59800	Passenger Ship	1,000	850	1,030	1350
Bulk Carrier	5,000	6,740	6,920	7190		2,000	1,580	1,910	2,500
	7,000	9,270	9,520	9880		3,000	2,270	2,740	3,590
	10,000	13,000	13,300	13800		5,000	3,580	4,320	5,650
	15,000	19,100	19,600	20300		7,000	4,830	5,830	7,630
	20,000	25,000	25,700	26700		10,000	6,640	8,010	10,500
	30,000	36,700	37,700	39100		15,000	9,530	11,500	15,000
	50,000	59,600	61,100	63500		20,000	12,300	14,900	19,400
	70,000	81,900	84,000	87200		30,000	17,700	21,300	27,900
	100,000	115,000	118,000	122000		50,000	27,900	33,600	44,000
	150,000	168,000	173,000	179000		70,000	37,600	45,300	59,300
	200,000	221,000	227,000	236000	Ferry	1,000	810	1,230	2,240
	250,000	273,000	280,000	291000		2,000	1,600	2,430	4,430
Container Ship	7,000	10200	10,700	11500		3,000	2,390	3,620	6,590
	10,000	14300	15,100	16200		5,000	3,940	5,970	10,900
	15,000	21100	22,200	23900		7,000	5,480	8,310	15,100
	20,000	27800	29,200	31400		10,000	7,770	11,800	21,500
	25,000	34300	36,100	38800		15,000	11,600	17,500	31,900
	30,000	40800	43,000	46200		20,000	15,300	23,300	42,300
	40,000	53700	56,500	60800		30,000	22,800	34,600	63,000
	50,000	66500	69,900	75200		40,000	30,300	45,900	83,500
	60,000	79100	83,200	89400					
Oil Tanker	1,000	1,450	1,580	1,800	Gas Carrier	1,000	2,210	2,480	2,910
	2,000	2,810	3,070	3,480		2,000	4,080	4,560	5,370
	3,000	4,140	4,520	5,130		3,000	5,830	6,530	7,680
	5,000	6,740	7,360	8,360		5,000	9,100	10,200	12,000
	7,000	9,300	10,200	11,500		7,000	12,300	13,800	16,200
	10,000	13,100	14,300	16,200		10,000	16,900	18,900	22,200
	15,000	19,200	21,000	23,900		15,000	24,100	27,000	31,700
	20,000	25,300	27,700	31,400		20,000	31,100	34,800	40,900
	30,000	37,300	40,800	46,300		30,000	44,400	49,700	58,500
	50,000	60,800	66,400	75,500		50,000	69,700	78,000	91,800
	70,000	83,900	91,600	104,000		70,000	94,000	105,000	124,000
	100,000	118,000	129,000	146,000		100,000	128,000	144,000	169,000
	150,000	174,000	190,000	216,000					
	200,000	229,000	250,000	284,000					
	300,000	337,000	368,000	418,000					

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