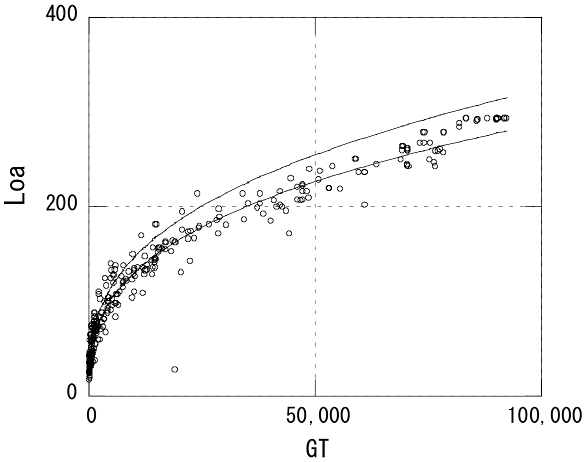
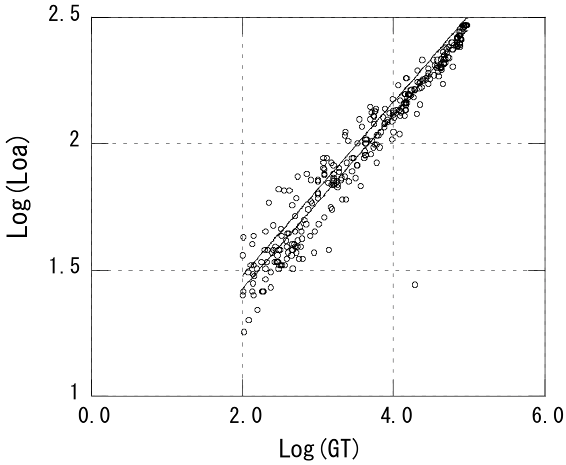




$Y=\alpha \cdot X^{\beta}$

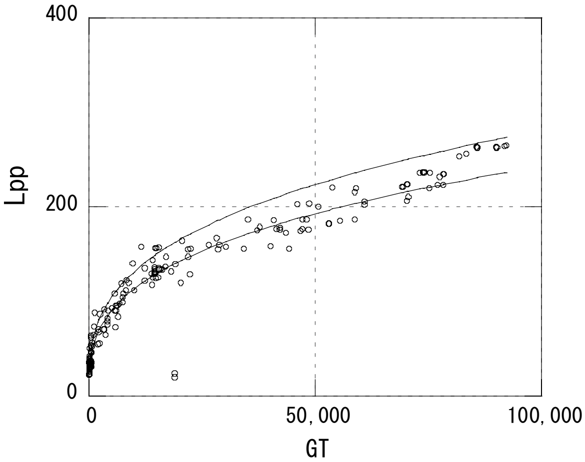
	50%	75%
α	5.4544	6.1331
β	0.3445	0.3445

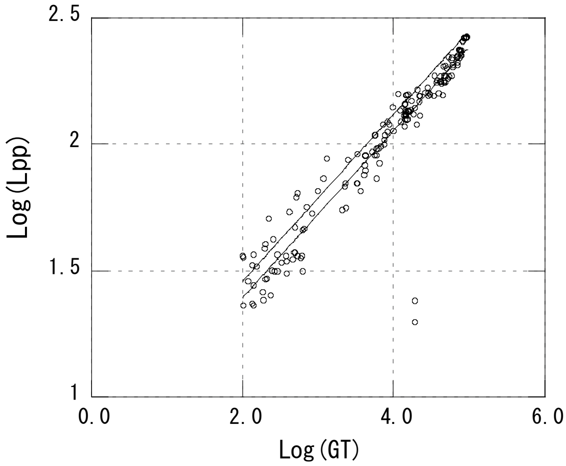
logY=a+blogX

(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





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

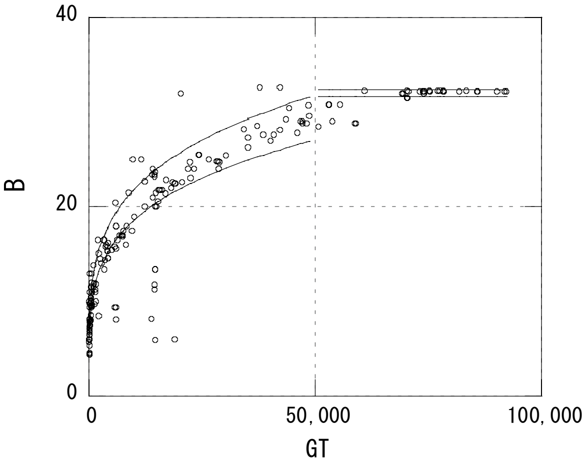
	50%	75%
α	5.3846	6.2400
β	0.3308	0.3308

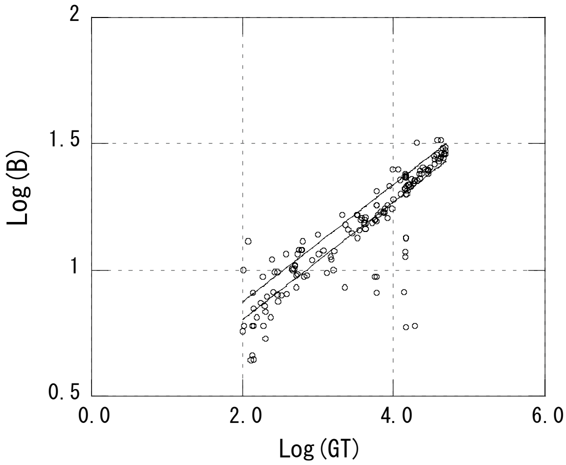
logY=a+blogX

(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

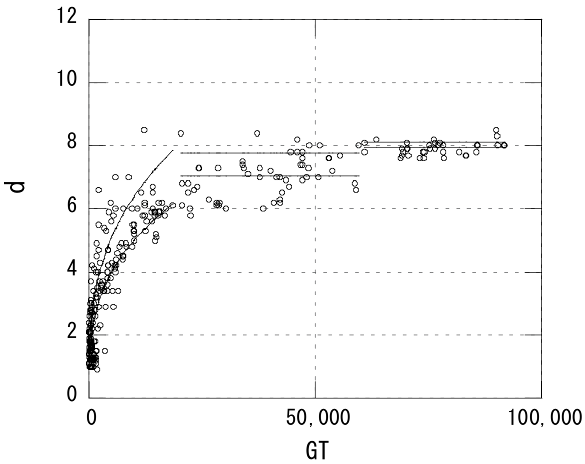
・50,000GT～100,000GT

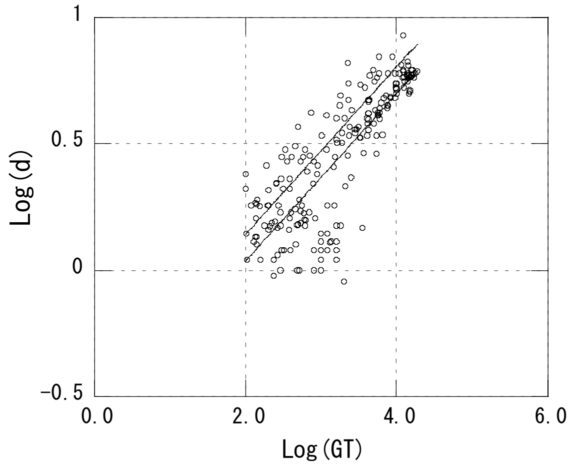
$Y=a_0$

（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.

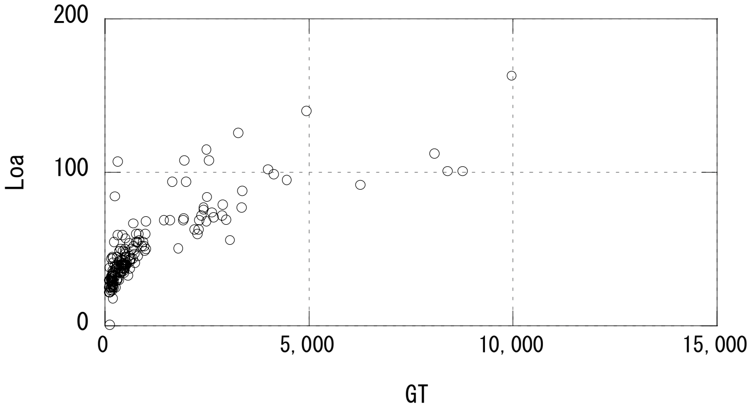


Figure 3-106 Ferry Loa-GT

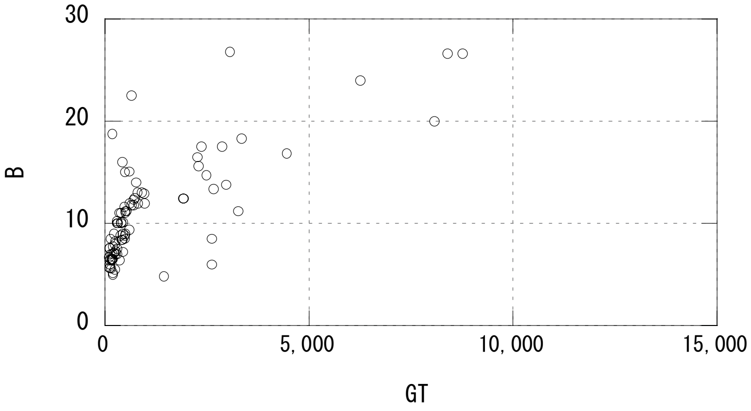


Figure 3-107 Ferry B-GT

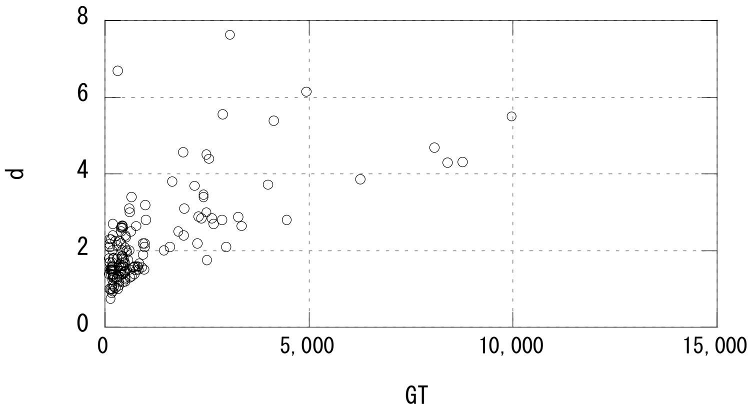


Figure 3-108 Ferry d-GT

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

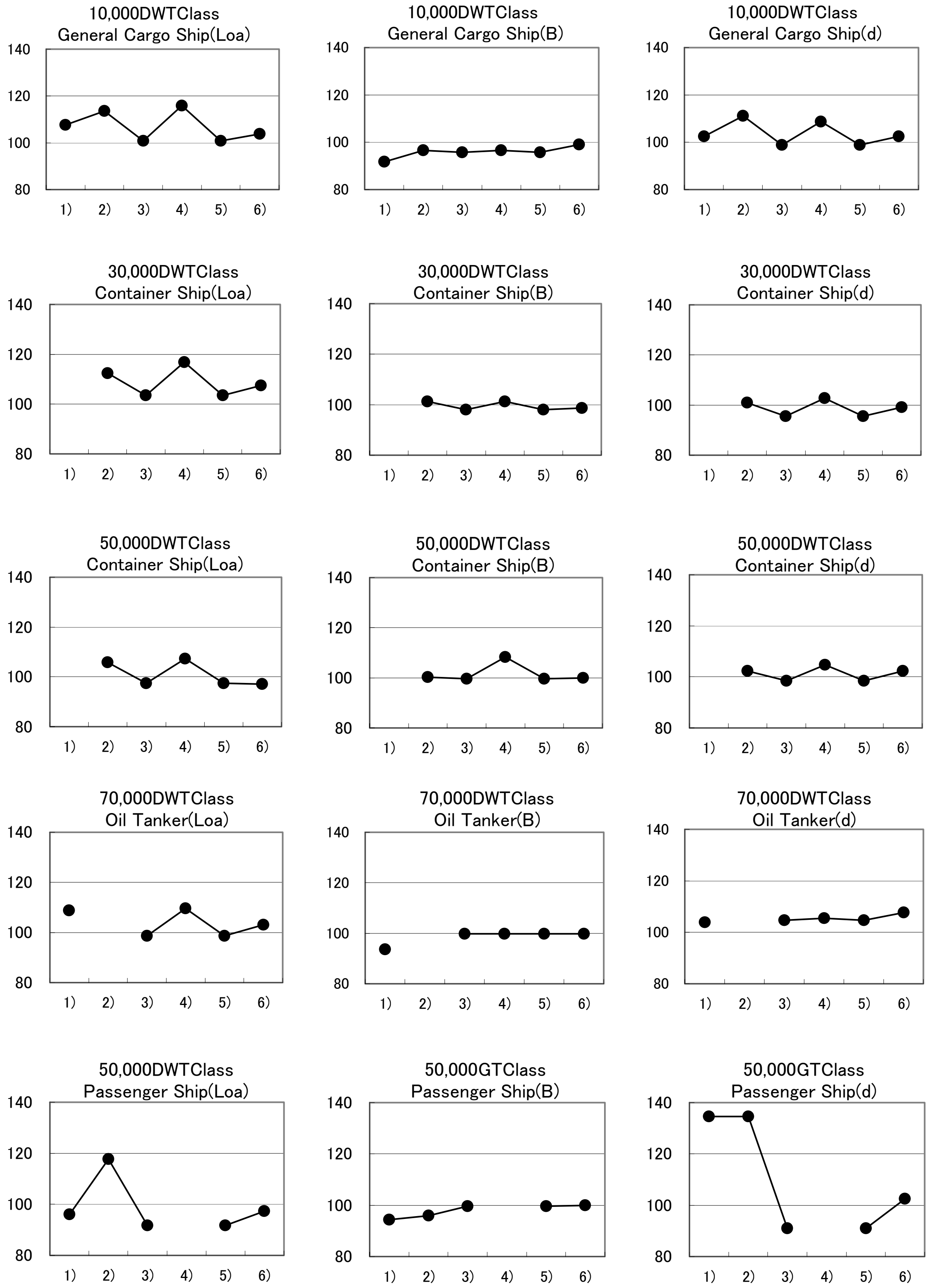


Figure 4-1 Cass where the 2005 standard is assumed to be 100

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

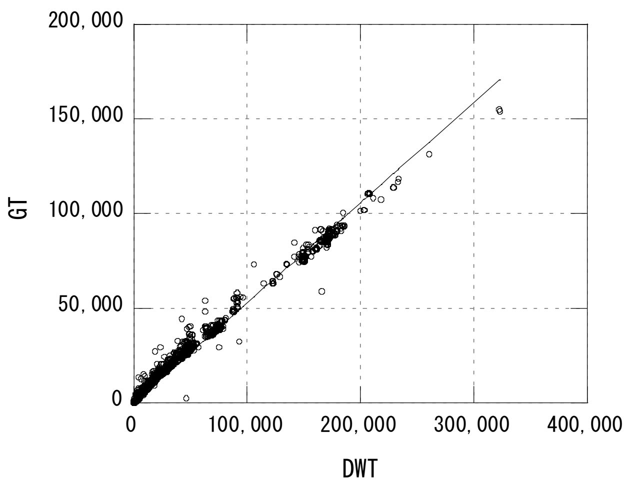


Figure 5-1 Cargo Ship DWT-GT

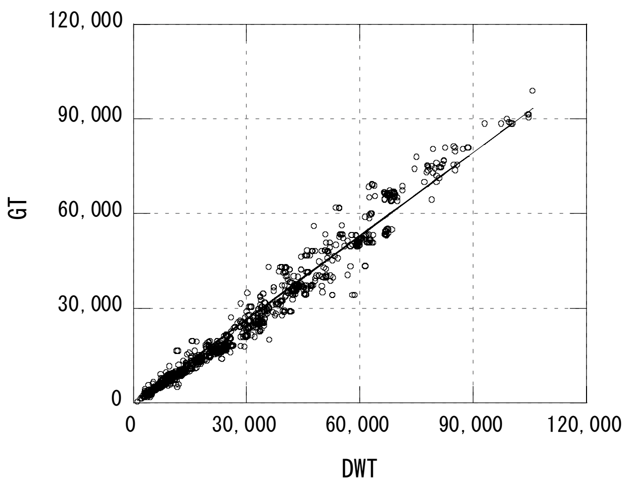


Figure 5-2 Container Ship DWT-GT

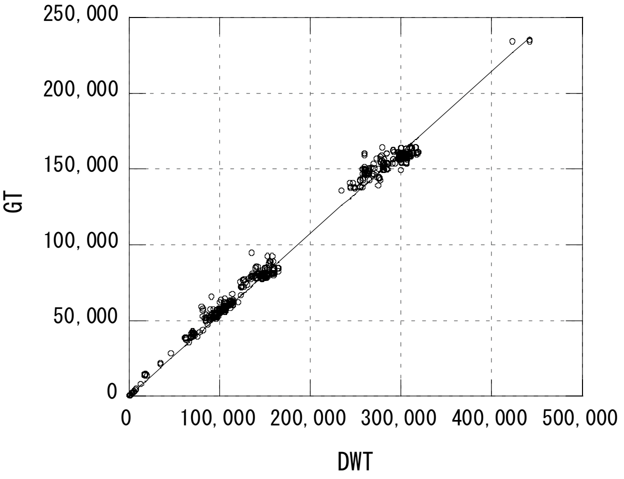


Figure 5-3 Oil Tanker DWT-GT

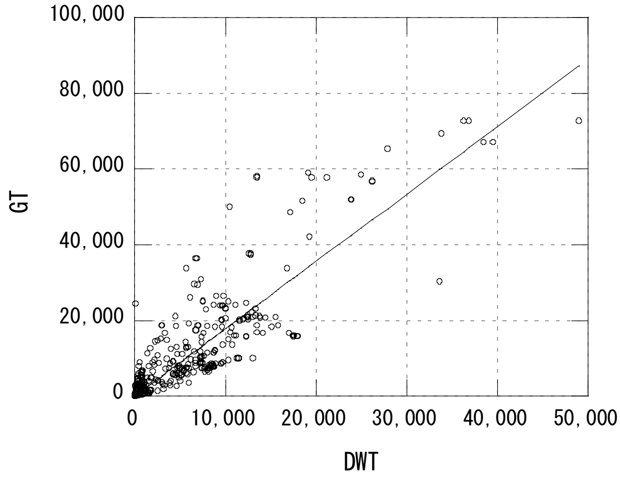


Figure 5-4 Roll-on/Roll-off Ship DWT-GT

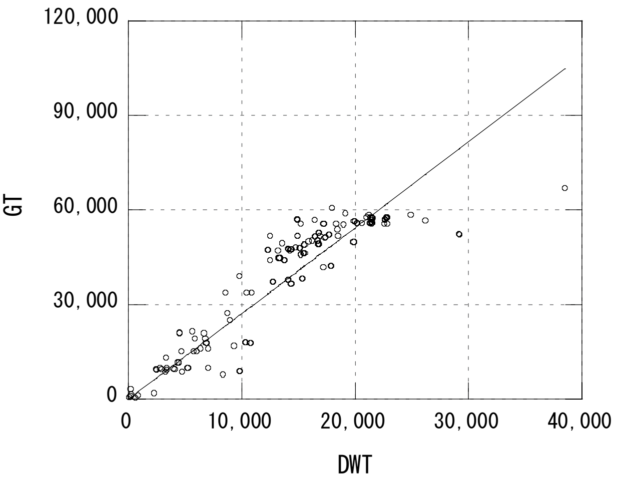


Figure 5-5 Pure Car Carrier Ship DWT-GT

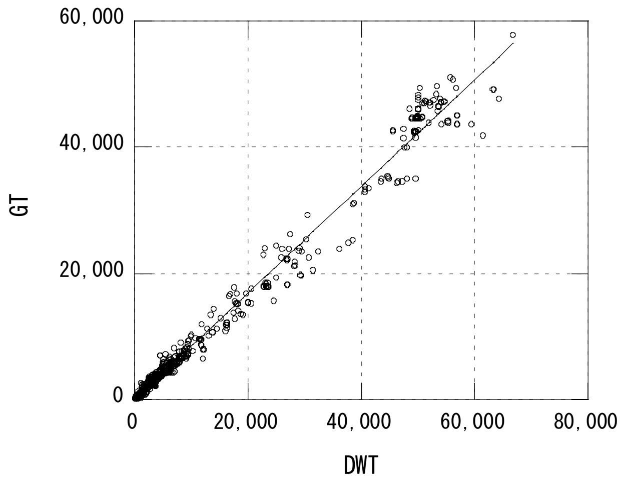


Figure 5-6 LPG Ship DWT-GT

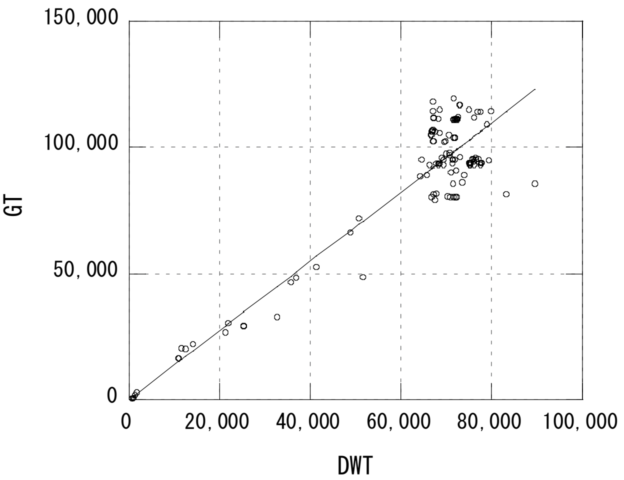


Figure 5-7 LNG Ship DWT-GT

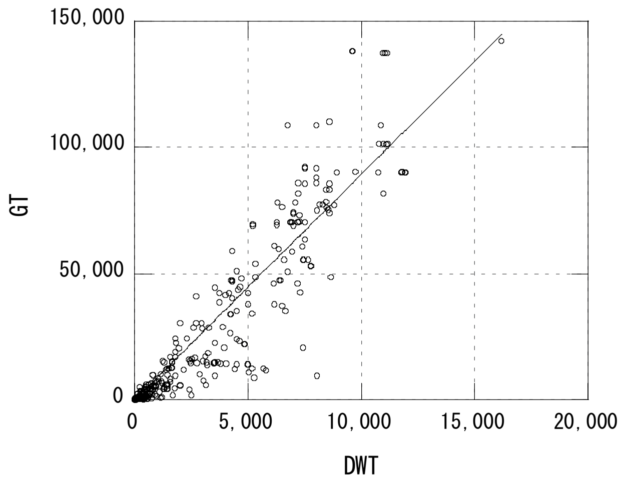


Figure 5-8 Passenger Ship DWT-GT

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

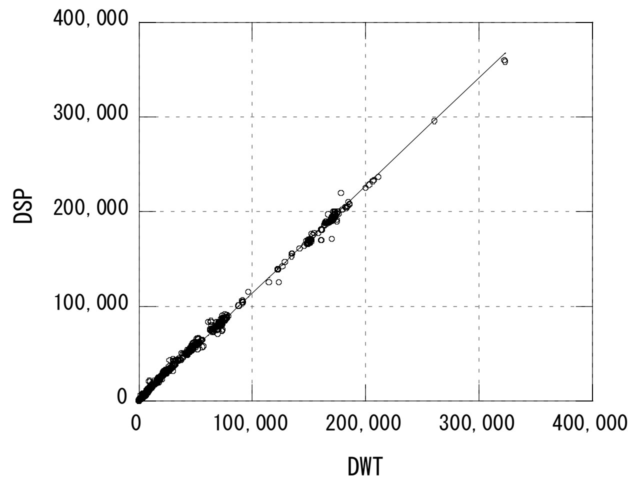


Figure 5-9 Cargo Ship DWT-DSP

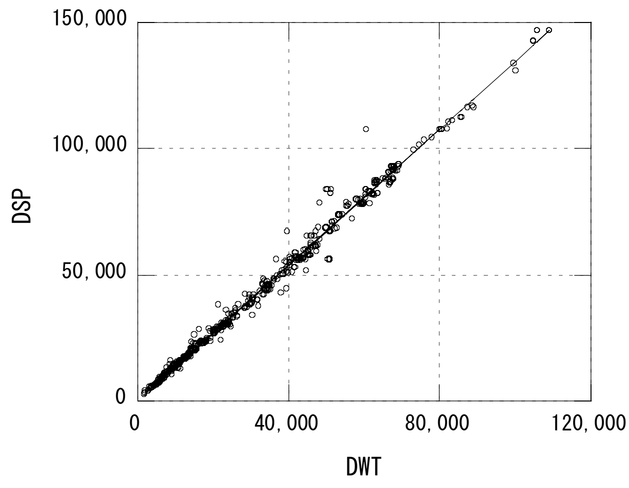


Figure 5-10 Container Ship DWT-DSP