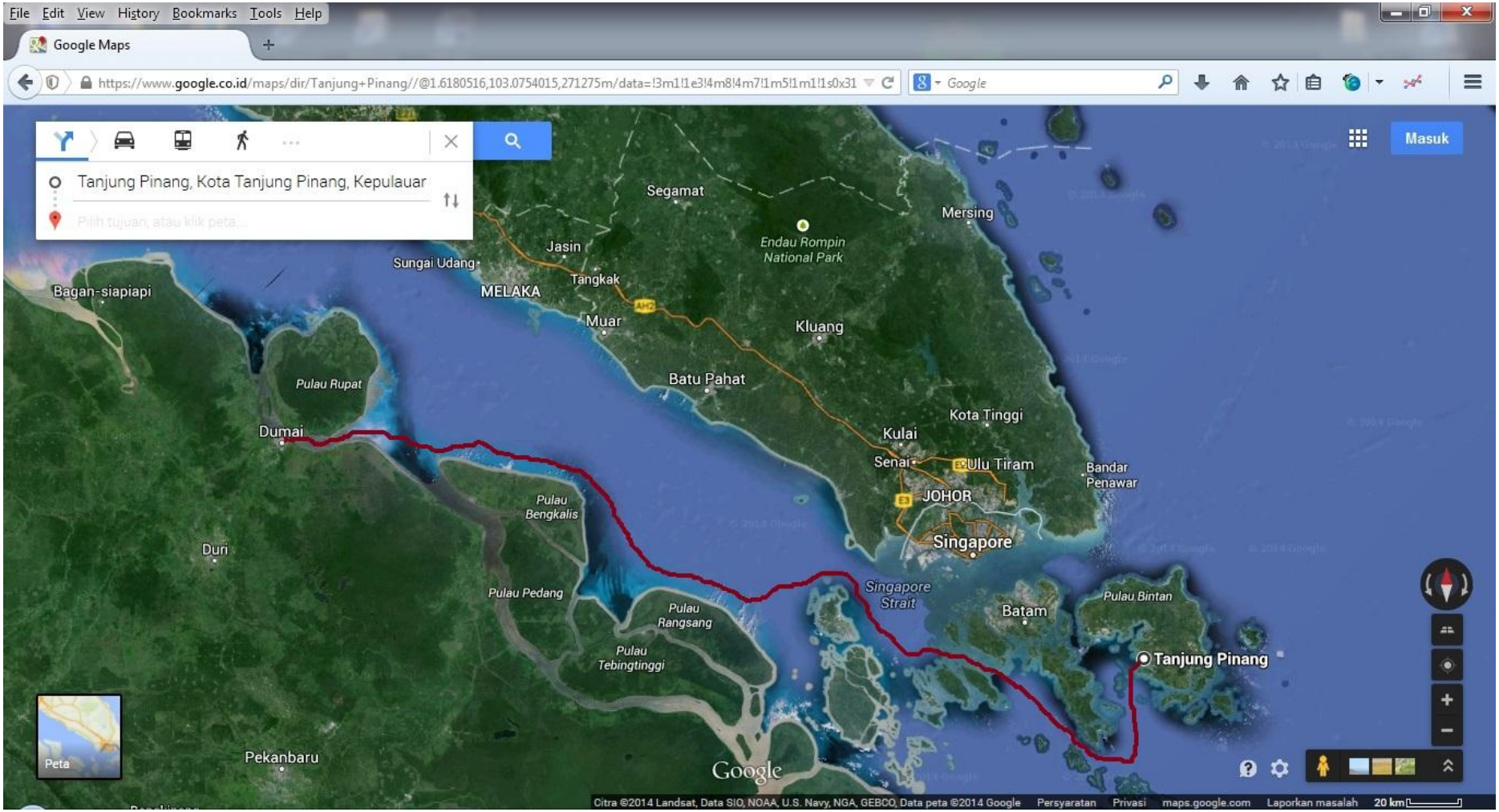
LAMPIRAN 1

PERBANDINGAN UKURAN UTAMA KAPAL PERENCANAAN GENERAL CARGO																				
DATA KAPAL PEMBANDING									RATIO KAPAL PEMBANDING				PERHITUNGAN KAPAL PERENCANAAN							KET.
NO.	NAMA KAPAL/ BUATAN	DWT 1	LOA 1	LWL 1	LBP 1	B 1	H 1	T 1	LBP 1 / B 1	B 1 / T 1	LBP 1 / H 1	LOA 1 / LBP 1	DWT 2	LOA 2	LWL 2	LBP 2 $\sqrt[3]{\frac{DWT_2}{DWT_1}}$	B 2 $\frac{LBP_2}{\text{Ratio}}$	H 2 $\frac{LBP_2}{\text{Ratio}}$	T 2 $\frac{B_2}{\text{Ratio}}$	
1	KENCANA NIAGA 52/ JAPAN	3500	91,91	85,68	84,00	14,03	5,94	5,40	5,987	2,598	14,141	1,094	3000	87,31	81,39	79,79	13,33	5,64	5,13	
2	NEW GLORY/ KOREA	3400	91,00	86,61	84,91	13,60	6,80	5,30	6,243	2,566	12,487	1,072	3000	87,28	83,07	81,44	13,04	6,52	5,08	
3	KARYA CITRA 8/ JAPAN	3100	90,57	86,56	84,86	12,50	7,80	5,90	6,789	2,119	10,879	1,067	3000	89,59	85,62	83,94	12,36	7,72	5,84	
4	ELEGANCE/ JAPAN	4200	93,74	87,31	85,60	13,20	8,05	4,55	6,485	2,901	10,634	1,095	3000	83,79	78,05	76,52	11,80	7,20	4,07	
5	**ASIA PERSADA/ JAPAN**	**3100**	**90,80**	**87,72**	**86,00**	**15,20**	**8,20**	**5,55**	**5,658**	**2,739**	**10,488**	**1,056**	3000	**89,81**	**86,77**	**85,07**	**15,03**	**8,11**	**5,49**	**OKE**
6	PEGASUS NUSANTARA/ KOREA	3400	91,00	86,61	84,91	13,60	6,80	5,56	6,243	2,446	12,487	1,072	3000	87,28	83,07	81,44	13,04	6,52	5,33	
7	NIAGA 56/ JAPAN	3500	91,91	85,68	84,00	14,00	6,90	5,60	6,000	2,500	12,174	1,094	3000	87,31	81,39	79,79	13,30	6,55	5,32	
8	BINTANG JASA 27/ BELGIUM	4100	93,65	87,31	85,60	13,02	7,90	6,10	6,575	2,134	10,835	1,094	3000	84,39	78,68	77,14	11,73	7,12	5,50	
9	MENTARI SUKSES/ CHINA	2900	85,80	82,74	81,12	15,00	7,30	5,30	5,408	2,830	11,112	1,058	3000	86,78	83,68	82,04	15,17	7,38	5,36	
10	BAHARI 2/ WESTERBROEK	2500	79,80	73,95	72,50	13,02	5,30	4,50	5,568	2,893	13,679	1,101	3000	84,80	78,58	77,04	13,84	5,63	4,78	
11	NUSANTARA/ JAPAN	2800	82,50	78,54	77,00	12,20	7,70	5,42	6,311	2,251	10,000	1,071	3000	84,42	80,37	78,79	12,48	7,88	5,55	
12	MULTI GUNA/ DENMARK	2500	79,65	75,14	73,67	13,25	6,40	5,15	5,560	2,573	11,511	1,081	3000	84,64	79,85	78,29	14,08	6,80	5,47	
13	ARTA SAMUDERA/ GERMANY	2800	82,00	79,60	78,04	12,82	5,15	4,50	6,087	2,849	15,153	1,051	3000	83,91	81,45	79,86	13,12	5,27	4,60	
14	CALYSTA/ DENMARK	2600	79,56	75,15	73,68	13,25	6,40	5,18	5,561	2,558	11,513	1,080	3000	83,45	78,83	77,28	13,90	6,71	5,43	
15	MULTI SPIRIT/ CHINA	3400	91,00	85,68	84,00	14,70	7,60	5,00	5,714	2,940	11,053	1,083	3000	87,28	82,18	80,57	14,10	7,29	4,80	

DATA KAPAL PERANCANGAN

DWT	**3000**	**DWT**
LOA	**90,00**	**M**
LWL	**86,80**	**M**
LBP	**85,00**	**M**
B	**15,00**	**M**
H	**8,10**	**M**
T	**5,50**	**M**
Cb	**0,67**	

Lampiran 2 Peta Radius Pelayaran



Lampiran 3

Perbandingan T/B dari kapal MV Gloryland General Cargo

Perbandingan T/B dari kapal MV Gloryland General Cargo

Perbandingan T/B dari kapal MV Gloryland General Cargo

Perbandingan Hid/B dari kapal MV Gloryland General Cargo

Perbandingan Hid/B dari kapal MV Gloryland General Cargo

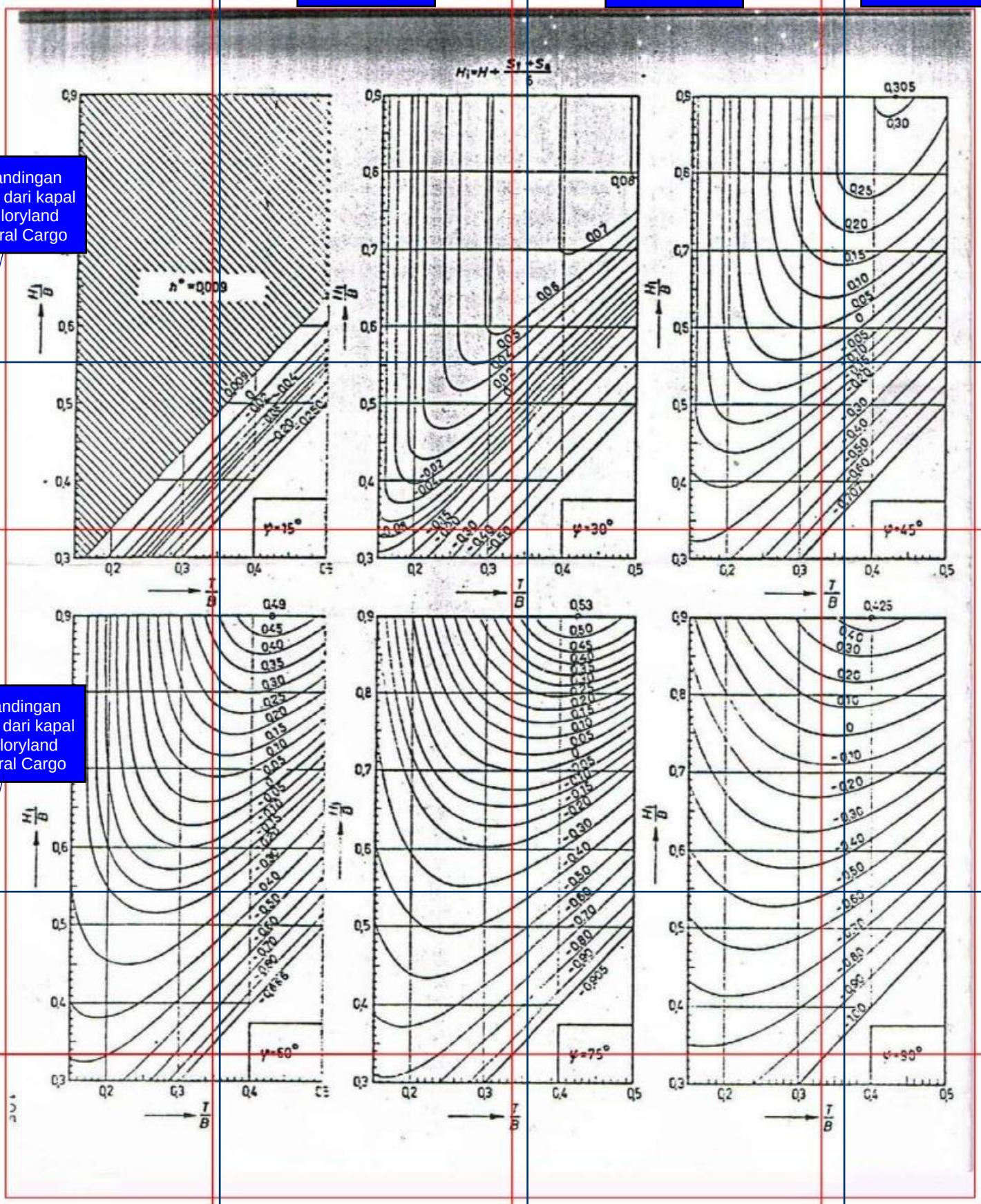
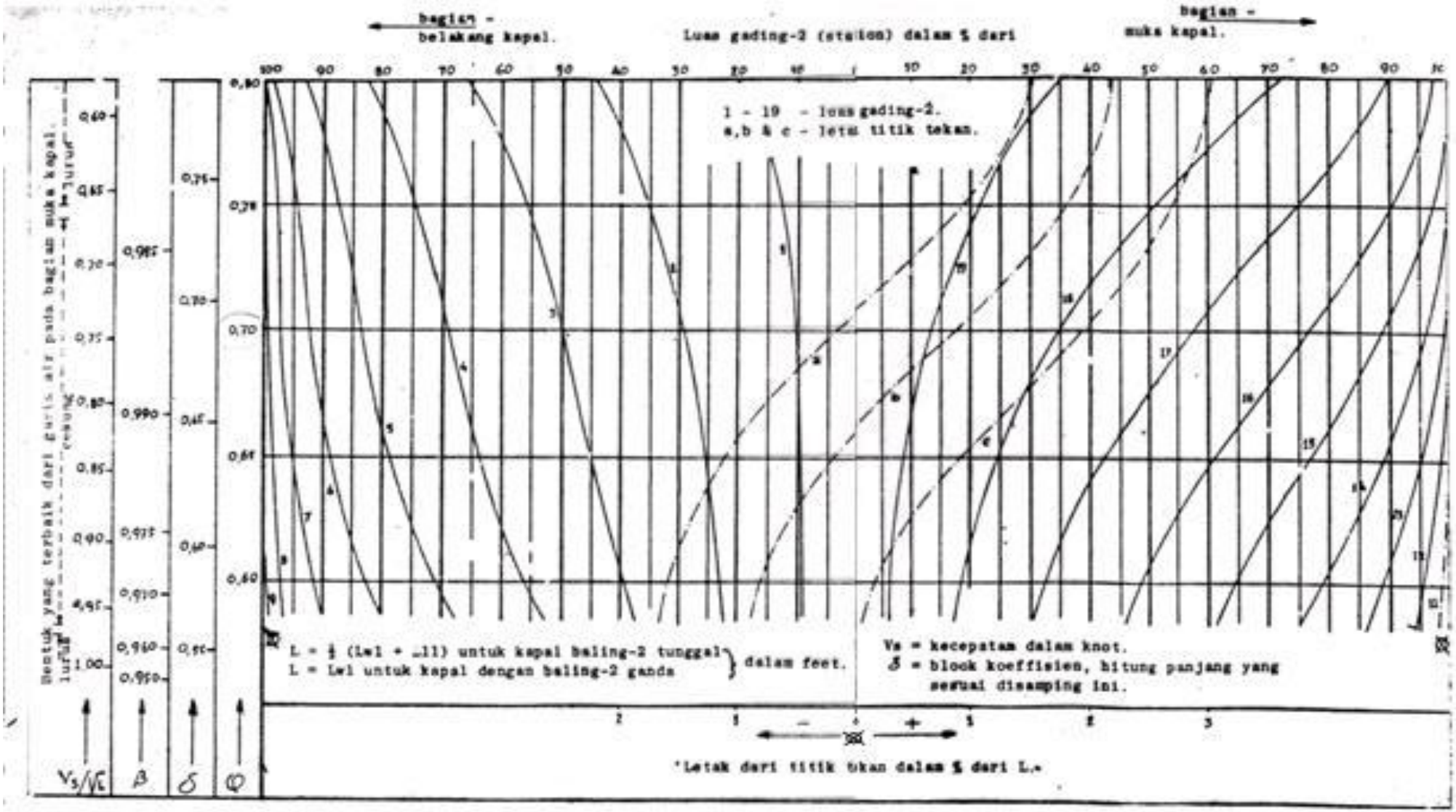


DIAGRAM PROHASKA

Lampiran 4

DIAGRAM NSP



NAME 338: Ship Design Project and Presentation

PROPELLER DESIGN

DR. MD. MASHUD KARIM
PROFESSOR
DEPT. OF NAME, BUET

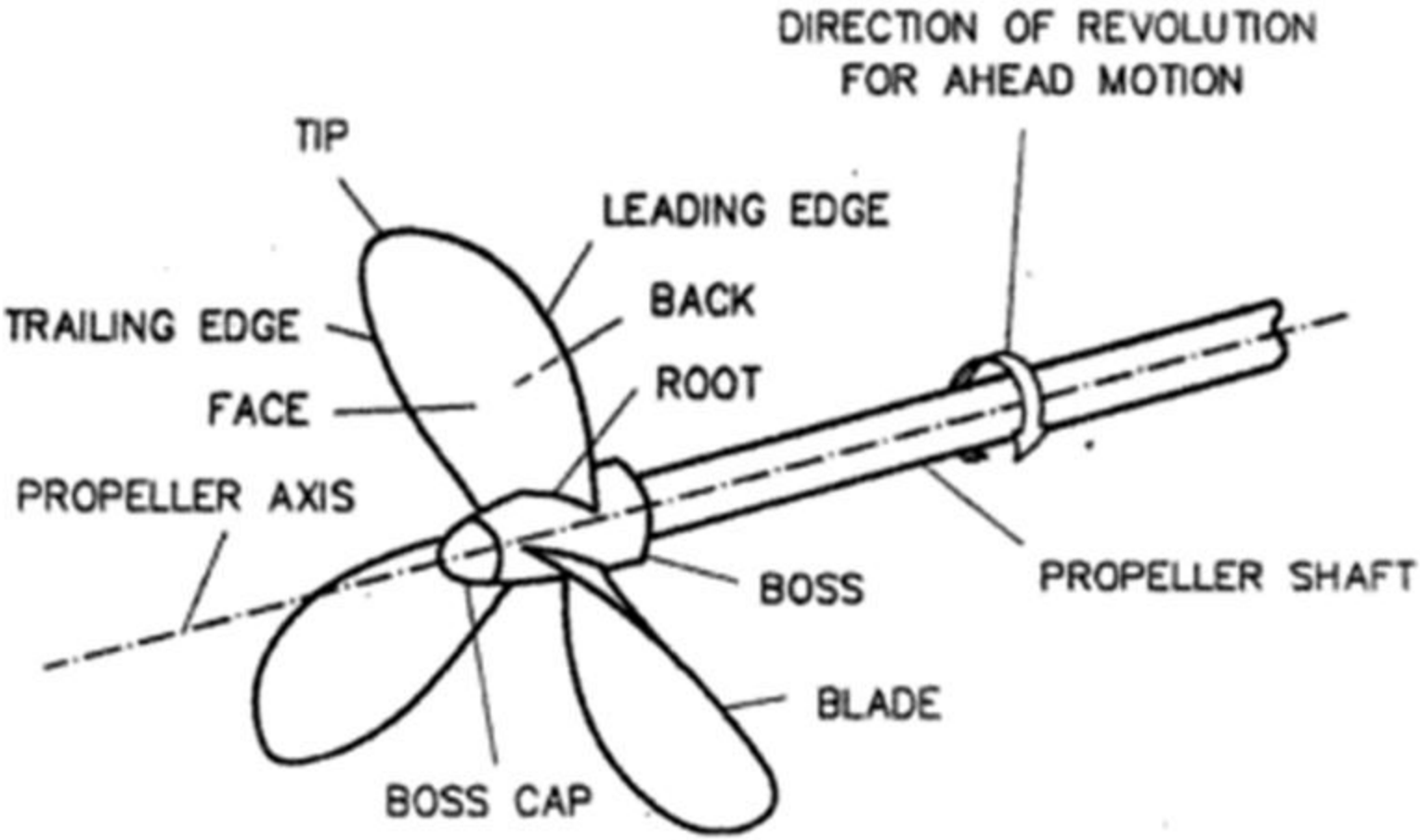


Figure 2.1 : A Three-Bladed Right Hand Propeller.

PROPELLER SPECIFICATIONS

1. Diameter
2. Revolutions per minute (RPM)
3. Pitch
4. Number of Blades
5. Rake and Skew
6. Hand (left/right handed screw)
7. Blade Section Shape
8. Blade thickness
9. Hub diameter
10. Shaft diameter
11. Blade area etc.
12. Supercavitating or noncavitating blades

PROPELLER DIAMETER

http://teacher.buet.ac.bd/minkarmy/

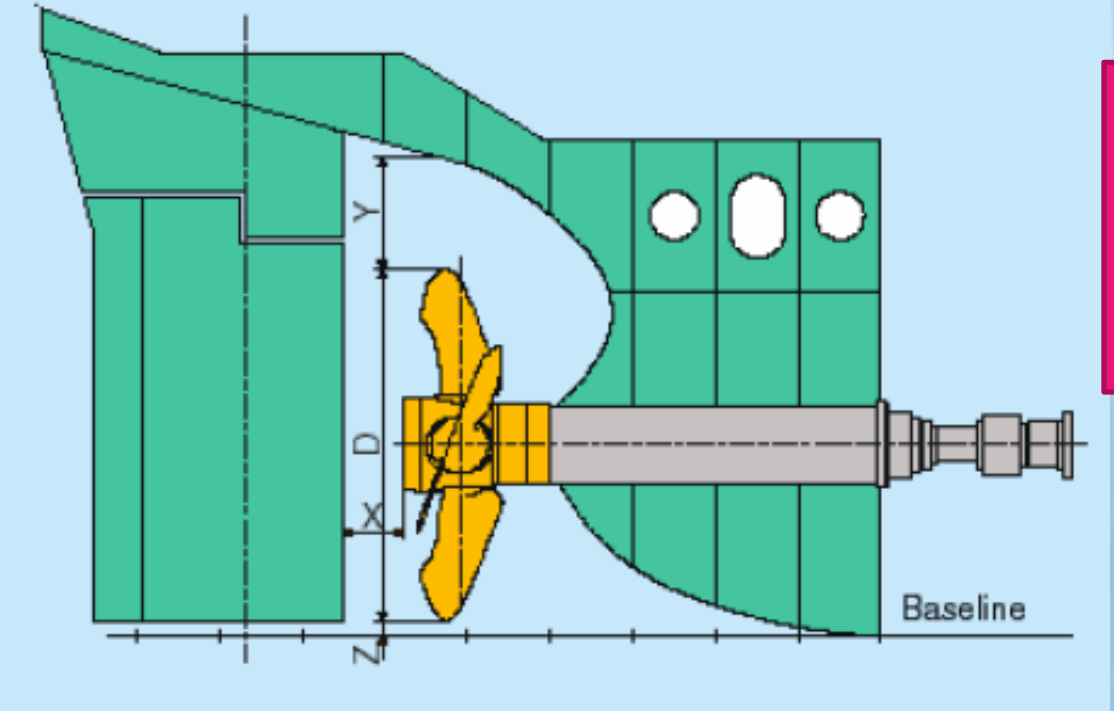
Diameter shoud be as large as possible

$D_{max} = D_B = aT$

a < 0.65 for Bulk carriers and Tankers

a < 0.74 for Containers ships

a < 2/3 for single screw



X = 5~10% D

Y = 15~25% D

Z = Up to 5% D

REVOLUTIONS PER MINUTE (RPM)

Torque Formula, Q = (5252 x HP)/RPM

Lower the shaft RPM and higher the HP, the greater the Torque

This is why slower turning propellers deliver more thrust—they are recieiving more torque for the same HP

Low speed engine is heavy and bulky wasting valuable interior hull space whereas high sped engine is light, compact and economical

A **reduction gear** is fitted between the crankshaft and the propeller shaft to reduce shaft RPM so that a larger diameter and more efficient propeller may be used.

PROPELLER DIAMETER

$D_B = 0.95 D_0$ for single screw

$D_B = 0.97 D_0$ for double screw

Where,

D_B = Propeller dia at behind condition

D_0 = Propeller dia at open water condition

NUMBER OF BLADES

One blade: Ideal, it does not have other blades disturbing the water flow ahead of it. Unfortunately, it will be unbalanced.

Two blades: It requires very large diameter to get the blade area required for effective thrust

Three blades: it has been proven to be the best compromise between balance, blade area and efficiency.

Four / Five blades: extra blades create more total blade area with the same or less Diameter. Accordingly, more thrust is produced. However, efficiency decreases due to additional turbulence

PITCH

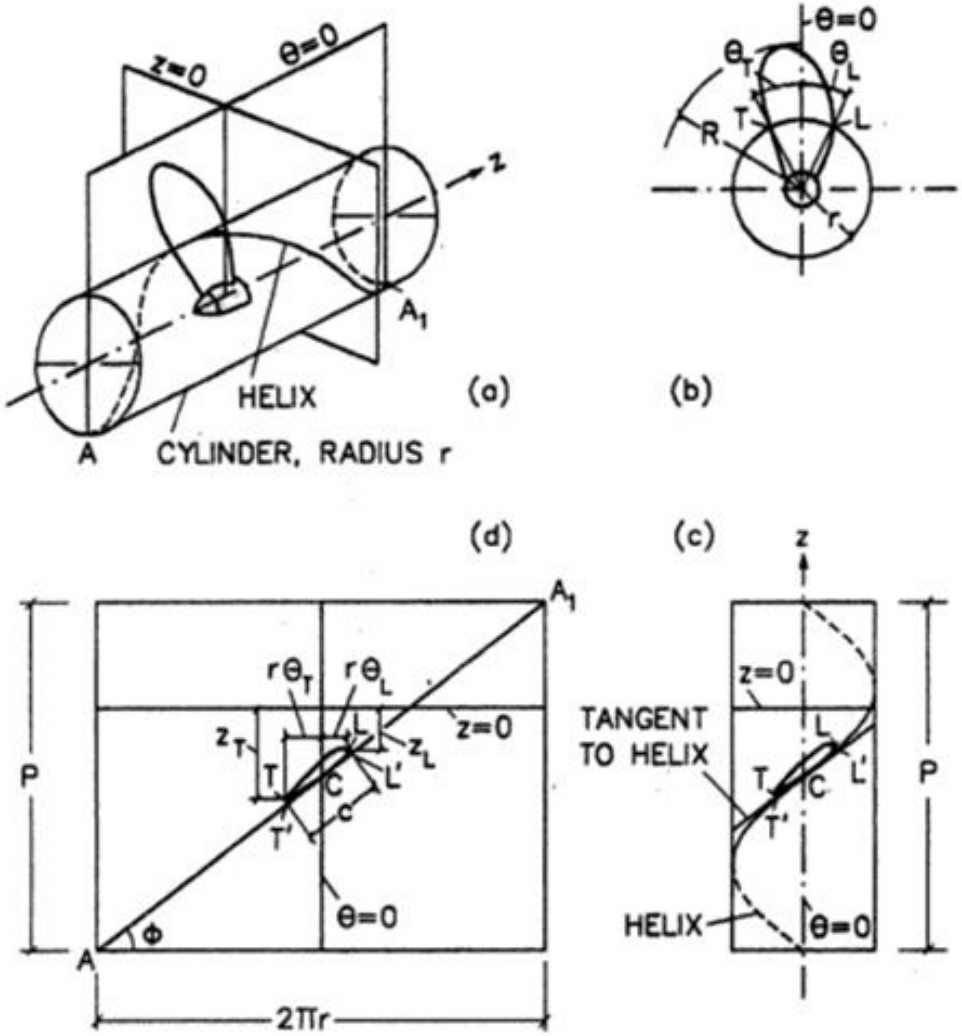


Figure 2.3 : Propeller Blade Cylindrical Section.

EFFECT OF PITCH

Pitch converts the torque of the propeller shaft to thrust by deflecting or accelerating water astern.

The fundamental task in selecting a propeller is to choose a pitch and diameter that will generate the maximum thrust possible at normal operating speed without overloading the engine

Large diameter, without pitch or angle of attack would not accelerate any water astern

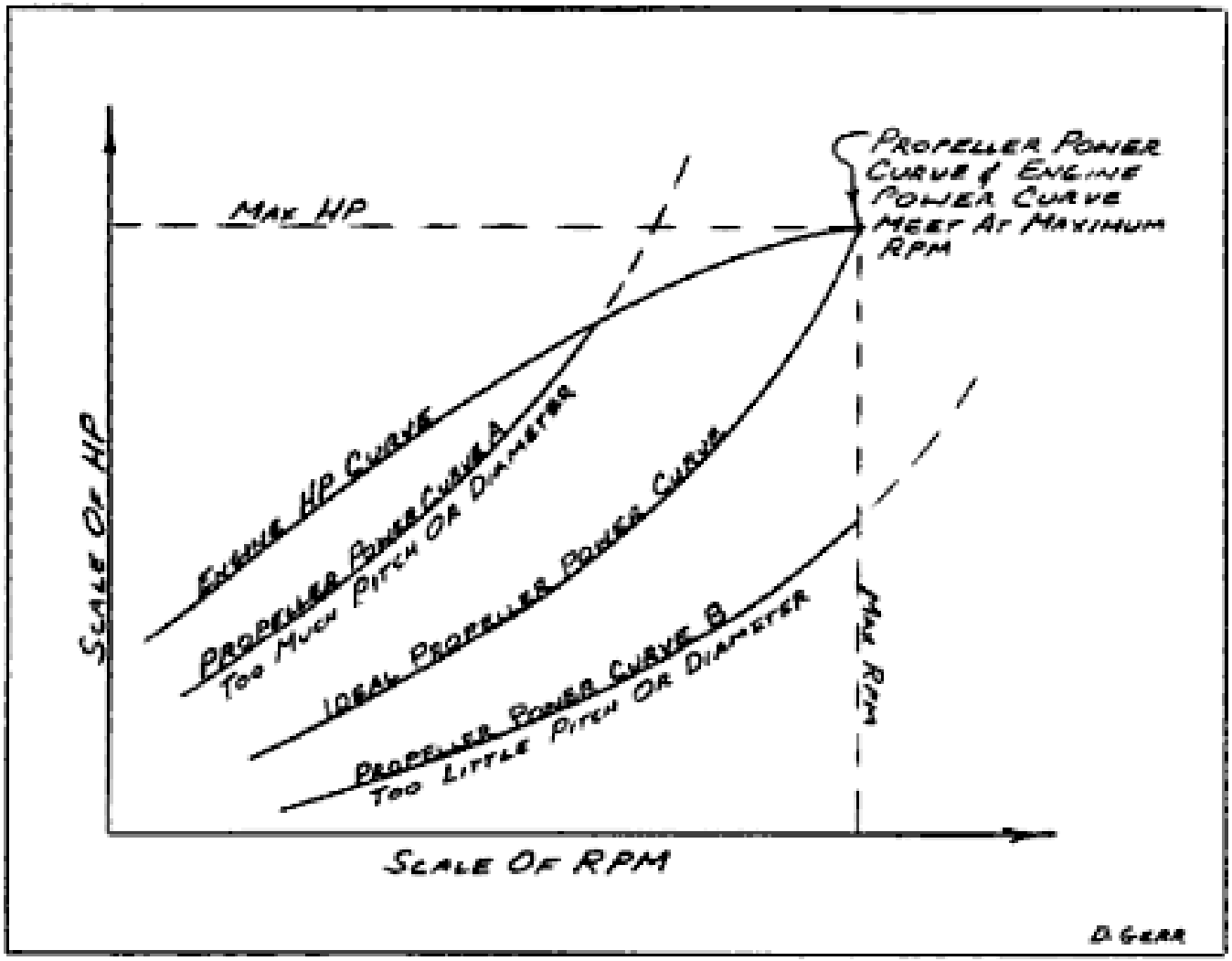
Similarly ordinary blades with too much pitch would attempt to force more water astern more quickly than the engine can accommodate.

Increasing pitch increases thrust but increasing pitch too much reduces the efficiency of the engine and propeller combination by slowing the engine

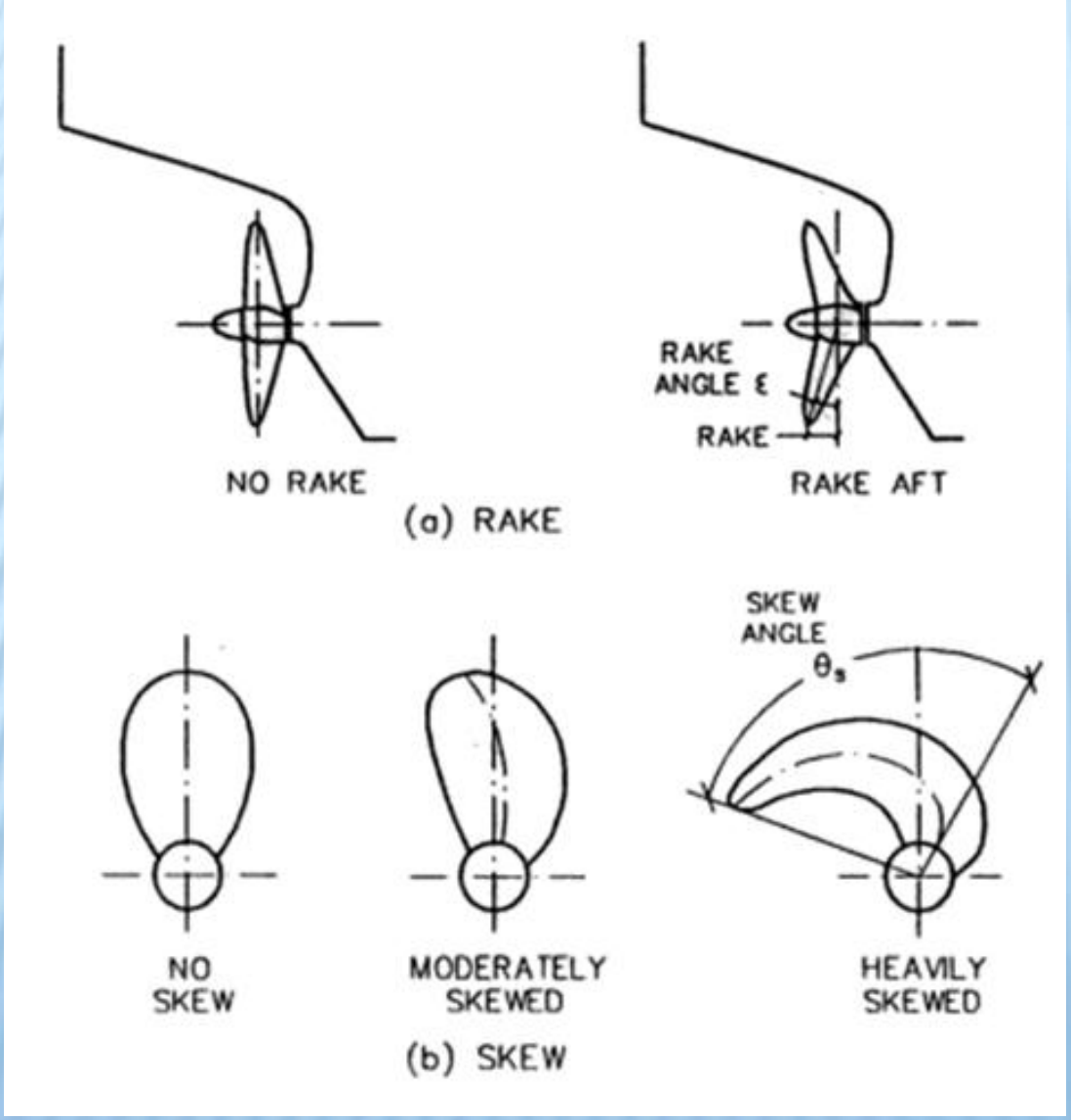
On the other hand, while too little pitch will not overload or slow the engine, it will not accelerate as much water astern and thus will not generate maximum possible thrust or speed

RELATIONSHIP OF ENGINE POWER TO PROPELLER POWER

http://teacher.buet.ac.bd/mmkarim/



RAKE & SKEW


NO RAKE
RAKE ANGLE ε
RAKE
RAKE AFT
(a) RAKE
SKEW ANGLE
θs
NO SKEW
MODERATELY SKEWED
HEAVILY SKEWED
(b) SKEW

HAND OF PROPELLER

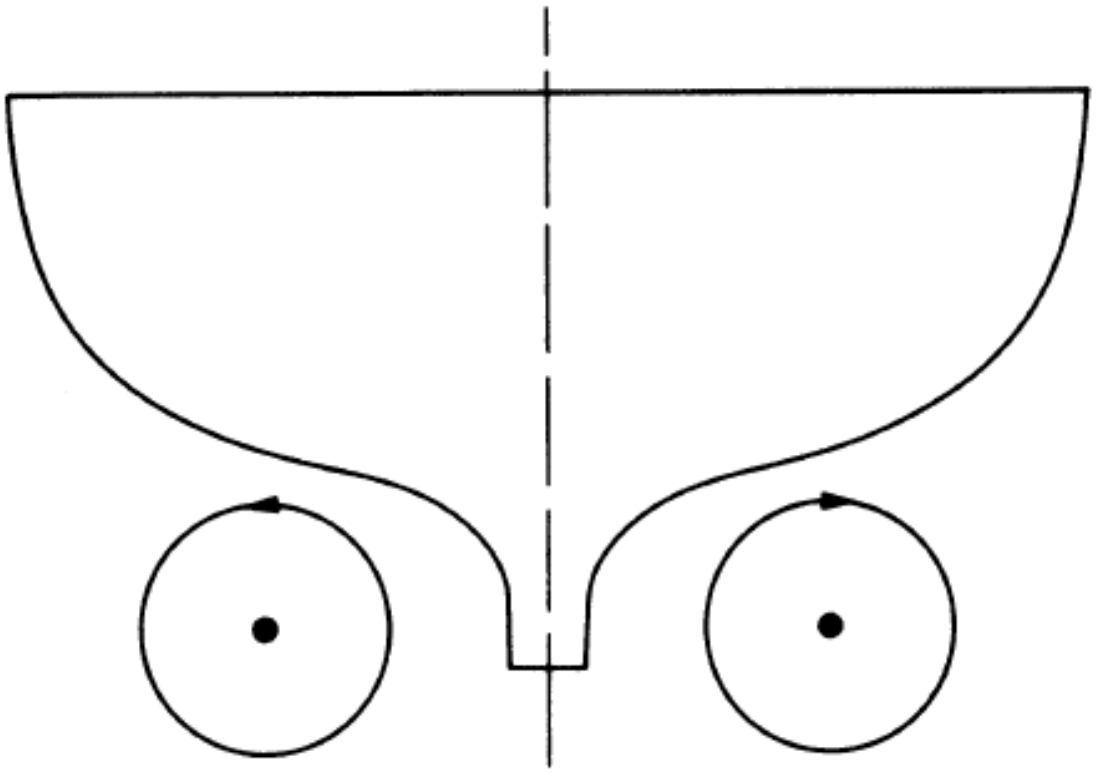


Fig. 10.8 Usual handing of propellers in a twin screw ship. Ship view from aft

If the propeller turn clockwise, it is said to be right-handed; if anti-clockwise, it is said to be left-handed. In a twin screw ship, the starboard propeller is normally right handed and the port propeller left-handed

PROJECTED, DEVELOPED & EXPANDED OUTLINE

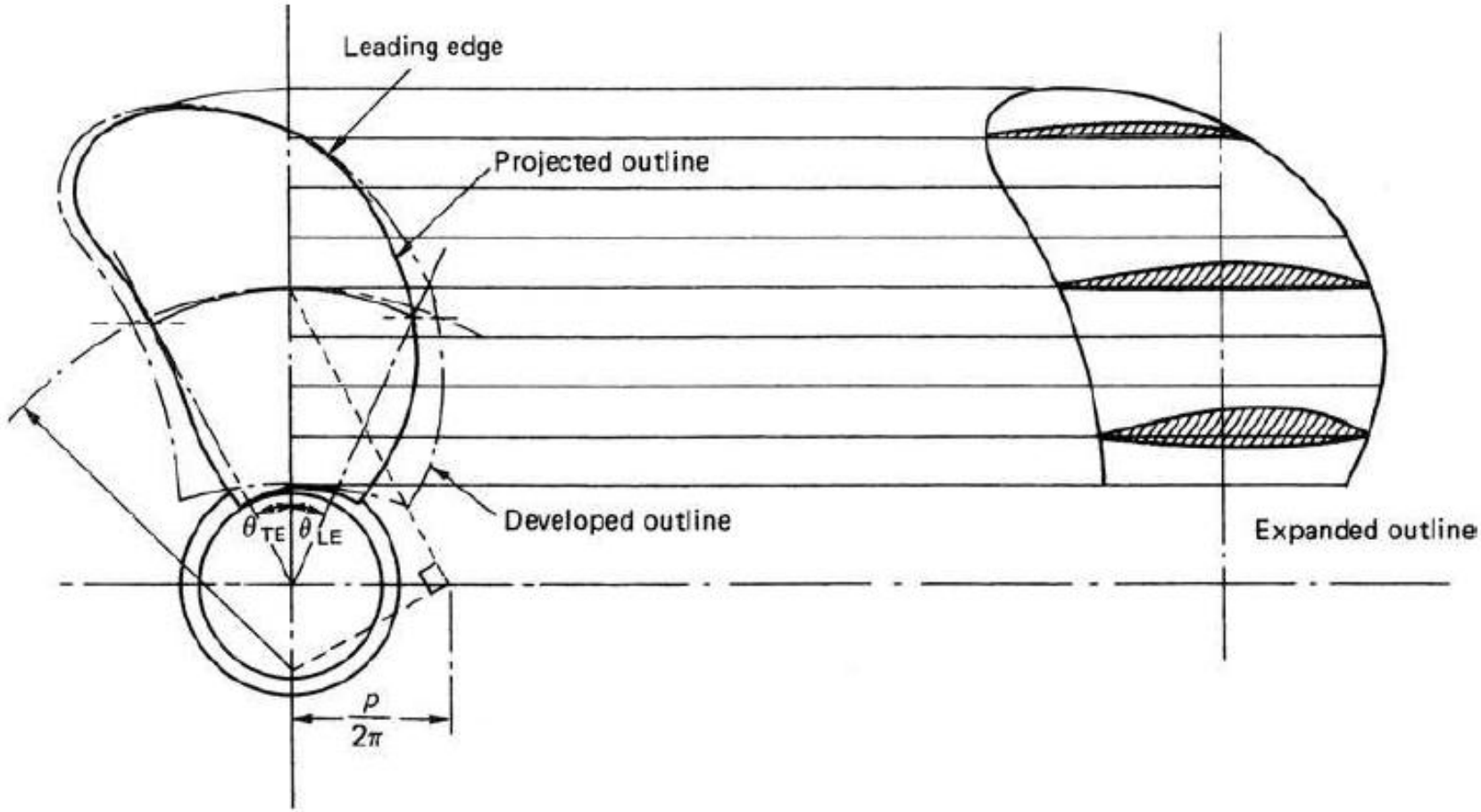


Figure 3.11 Outline definition

BLADE NO. & BAR

Table 6.4 Extent of the Wageningen B-screw series (taken from Reference 6)

Blade number (Z)	*Blade area ratio A_E/A_O*																
2	0.30																
3		0.35				0.50				0.65				0.80			
4			0.40				0.55				0.70				0.85	1.00	
5				0.45				0.60				0.75					1.05
6						0.50				0.65				0.80			
7							0.55				0.70				0.85		

TORQUE & THRUST COEFFICIENTS

$$\left.\begin{aligned} K_Q &= \sum_{n=1}^{47} C_n (J)^{S_n} (P/D)^{t_n} (A_E/A_O)^{u_n} (Z)^{v_n} \\ K_T &= \sum_{n=1}^{39} C_n (J)^{S_n} (P/D)^{t_n} (A_E/A_O)^{u_n} (Z)^{v_n} \end{aligned}\right\} \quad (6$$

where the coefficients are reproduced in Table 6.6.

COEFFICIENTS OF KT & KQ

Table 6.6 Coefficients for the K_T and K_Q polynomials representing the Wageningen B-screen series for a Reynolds number of 2×10^6 (taken from Reference 7)

Thrust (K_T)						*Torque* (K_Q)					
n	$C_{s,t,u,v}$	$s(J)$	$t(P/D)$	$u(A_E/A_O)$	$v(Z)$	n	$C_{s,t,u,v}$	$s(J)$	$t(P/D)$	$u(A_E/A_O)$	$v(Z)$
1	+0.00880496	0	0	0	0	1	+0.00379368	0	0	0	0
2	−0.204554	1	0	0	0	2	+0.00886523	2	0	0	0
3	+0.166351	0	1	0	0	3	−0.032241	1	1	0	0
4	+0.158114	0	2	0	0	4	+0.00344778	0	2	0	0
5	−0.147581	2	0	1	0	5	−0.0408811	0	1	1	0
6	−0.481497	1	1	1	0	6	−0.108009	1	1	1	0
7	+0.415437	0	2	1	0	7	−0.0885381	2	1	1	0
8	+0.0144043	0	0	0	1	8	+0.188561	0	2	1	0
9	−0.0530054	2	0	0	1	9	−0.00370871	1	0	0	1
10	+0.0143481	0	1	0	1	10	+0.00513696	0	1	0	1
11	+0.0606826	1	1	0	1	11	+0.0209449	1	1	0	1
12	−0.0125894	0	0	1	1	12	+0.00474319	2	1	0	1
13	+0.0109689	1	0	1	1	13	−0.00723408	2	0	1	1
14	−0.133698	0	3	0	0	14	+0.00438388	1	1	1	1
15	+0.00638407	0	6	0	0	15	−0.0269403	0	2	1	1
16	−0.00132718	2	6	0	0	16	+0.0558082	3	0	1	0
17	+0.168496	3	0	1	0	17	+0.0161886	0	3	1	0
18	−0.0507214	0	0	2	0	18	+0.00318086	1	3	1	0
19	+0.0854559	2	0	2	0	19	+0.015896	0	0	2	0
20	−0.0504475	3	0	2	0	20	+0.0471729	1	0	2	0
21	+0.010465	1	6	2	0	21	+0.0196283	3	0	2	0
22	−0.00648272	2	6	2	0	22	−0.0502782	0	1	2	0
23	−0.00841728	0	3	0	1	23	−0.030055	3	1	2	0
24	+0.0168424	1	3	0	1	24	+0.0417122	2	2	2	0
25	−0.00102296	3	3	0	1	25	−0.0397722	0	3	2	0
26	−0.0317791	0	3	1	1	26	−0.00350024	0	6	2	0
27	+0.018604	1	0	2	1	27	−0.0106854	3	0	0	1
28	−0.00410798	0	2	2	1	28	+0.00110903	3	3	0	1
29	−0.000606848	0	0	0	2	29	−0.000313912	0	6	0	1
30	−0.0049819	1	0	0	2	30	+0.0035985	3	0	1	1
31	+0.0025983	2	0	0	2	31	−0.00142121	0	6	1	1
32	−0.000560528	3	0	0	2	32	−0.00383637	1	0	2	1
33	−0.00163652	1	2	0	2	33	+0.0126803	0	2	2	1
34	−0.000328787	1	6	0	2	34	−0.00318278	2	3	2	1
35	+0.000116502	2	6	0	2	35	+0.00334268	0	6	2	1
36	+0.000690904	0	0	1	2	36	−0.00183491	1	1	0	2
37	+0.00421749	0	3	1	2	37	+0.000112451	3	2	0	2
38	+0.0000565229	3	6	1	2	38	−0.0000297228	3	6	0	2
39	−0.00146564	0	3	2	2	39	+0.000269551	1	0	1	2
						40	+0.00083265	2	0	1	2
						41	+0.00155334	0	2	1	2
						42	+0.000302683	0	6	1	2
						43	−0.0001843	0	0	2	2
						44	−0.000425399	0	3	2	2
						45	+0.0000869243	3	3	2	2
						46	−0.0004659	0	6	2	2
						47	+0.0000554194	1	6	2	2

EFFECT OF REYNOLD'S NUMBER

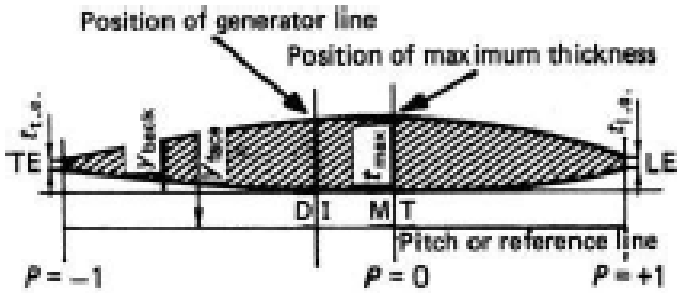
$$\begin{Bmatrix} K_T(R_n) \\ K_Q(R_n) \end{Bmatrix} = \begin{Bmatrix} K_T(R_n = 2 \times 10^6) \\ K_Q(R_n = 2 \times 10^6) \end{Bmatrix} + \begin{Bmatrix} \Delta K_T(R_n) \\ \Delta K_Q(R_n) \end{Bmatrix} \tag{6.18}$$

where

$$\begin{aligned}
\Delta K_T = \; & 0.000353485 \\
& - 0.00333758\,(A_E/A_O)J^2 \\
& - 0.00478125\,(A_E/A_O)(P/D)J \\
& + 0.000257792(\log R_n - 0.301)^2 \cdot (A_E/A_O)J^2 \\
& + 0.0000643192(\log R_n - 0.301)(P/D)^6 J^2 \\
& - 0.0000110636(\log R_n - 0.301)^2 (P/D)^6 J^2 \\
& - 0.0000276305(\log R_n - 0.301)^2 Z(A_E/A_O)J^2 \\
& + 0.0000954(\log R_n - 0.301)Z(A_E/A_O)(P/D)J \\
& + 0.0000032049(\log R_n - 0.301)Z^2(A_E/A_O) \\
& \quad \times (P/D)^3 J
\end{aligned}$$

$$\begin{aligned}
\Delta K_Q = \; & -0.000591412 \\
& + 0.00696898(P/D) \\
& - 0.0000666654Z(P/D)^6 \\
& + 0.0160818(A_E/A_O)^2 \\
& - 0.000938091(\log R_n - 0.301)(P/D) \\
& - 0.00059593(\log R_n - 0.301)(P/D)^2 \\
& + 0.0000782099(\log R_n - 0.301)^2 (P/D)^2 \\
& + 0.0000052199(\log R_n - 0.301)Z(A_E/A_O)J^2 \\
& - 0.00000088528(\log R_n - 0.301)^2 Z(A_E/A_O) \\
& \quad \times (P/D)J \\
& + 0.0000230171(\log R_n - 0.301)Z(P/D)^6 \\
& - 0.00000184341(\log R_n - 0.301)^2 Z(P/D)^6 \\
& - 0.00400252(\log R_n - 0.301)(A_E/A_O)^2 \\
& + 0.000220915(\log R_n - 0.301)^2 (A_E/A_O)^2
\end{aligned}$$

GEOMETRY OF B-SERIES PROPELLER



LE = leading edge
TE = trailing edge
MT = location of maximum thickness
D1 = location of directrix

$$\left.\begin{aligned} Y_{face} &= V_1(t_{max} - t_{t.e.}) \\ Y_{back} &= (V_1 + V_2)(t_{max} - t_{t.e.}) + t_{t.e.} \end{aligned}\right\} \text{ for } P \le 0$$

and

$$\left.\begin{aligned} Y_{face} &= V_1(t_{max} - t_{l.e.}) \\ Y_{back} &= (V_1 + V_2)(t_{max} - t_{l.e.}) + t_{l.e.} \end{aligned}\right\} \text{ for } P \ge 0$$

Referring to the diagram, note the following:

Y_{face}, Y_{back} — vertical ordinate of a point on a blade section on the face and on the back with respect to the pitch line.

t_{max} — maximum thickness of blade section.

$t_{t.e.r}, t_{l.e.}$ — extrapolated blade section thickness at the trailing and leading edges.

V_1, V_2 — tabulated functions dependent on r/R and P.

P — non-dimensional coordinate along pitch line from position of maximum thickness to leading edge (where $P = 1$), and from position of maximum thickness to trailing edge (where $P = -1$).

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GEOMETRY OF B-SERIES PROPELLER

Table 6.5 Geometry of the Wageningen B-screw series (taken fr

Dimensions of four-, five-, six- and seven-bladed propellers

r/R	$\frac{c}{D} \cdot \frac{Z}{A_E/A_O}$	a/c	b/c	$t/D = A_r - B_r Z$	
				A_r	B_r
0.2	1.662	0.617	0.350	0.0526	0.0040
0.3	1.882	0.613	0.350	0.0464	0.0035
0.4	2.050	0.601	0.351	0.0402	0.0030
0.5	2.152	0.586	0.355	0.0340	0.0025
0.6	2.187	0.561	0.389	0.0278	0.0020
0.7	2.144	0.524	0.443	0.0216	0.0015
0.8	1.970	0.463	0.479	0.0154	0.0010
0.9	1.582	0.351	0.500	0.0092	0.0005
1.0	0.000	0.000	0.000	0.0030	0.0000

Dimensions for three-bladed propellers

r/R	$\frac{c}{D} \cdot \frac{Z}{A_E/A_O}$	a/c	b/c	$t/D = A_r - B_r Z$	
				A_r	B_r
0.2	1.633	0.616	0.350	0.0526	0.0040
0.3	1.832	0.611	0.350	0.0464	0.0035
0.4	2.000	0.599	0.350	0.0402	0.0030
0.5	2.120	0.583	0.355	0.0340	0.0025
0.6	2.186	0.558	0.389	0.0278	0.0020
0.7	2.168	0.526	0.442	0.0216	0.0015
0.8	2.127	0.481	0.478	0.0154	0.0010
0.9	1.657	0.400	0.500	0.0092	0.0005
1.0	0.000	0.000	0.000	0.0030	0.0000

A_r, B_r = constants in equation for t/D.
a = distance between leading edge and generator line at r.
b = distance between leading edge and location of maximum thickness.
c = chord length of blade section ar radius r.
t = maximum blade section thickness at radius r

VALUES OF V1

Values of V_1 for use in the equations

r_j/R	P	−1.0	−0.95	−0.9	−0.8	−0.7	−0.6	−0.5	−0.4	−0.2	0
0.7–1.0		0	0	0	0	0	0	0	0	0	0
0.6		0	0	0	0	0	0	0	0	0	0
0.5		0.0522	0.0420	0.0330	0.0190	0.0100	0.0040	0.0012	0	0	0
0.4		0.1467	0.1200	0.0972	0.0630	0.0395	0.0214	0.0116	0.0044	0	0
0.3		0.2306	0.2040	0.1790	0.1333	0.0943	0.0623	0.0376	0.0202	0.0033	0
0.25		0.2598	0.2372	0.2115	0.1651	0.1246	0.0899	0.0579	0.0350	0.0084	0
0.2		0.2826	0.2630	0.2400	0.1967	0.1570	0.1207	0.0880	0.0592	0.0172	0
0.15		0.3000	0.2824	0.2650	0.2300	0.1950	0.1610	0.1280	0.0955	0.0365	0

r_j/R	P	+1.0	+0.95	+0.9	+0.85	+0.8	+0.7	+0.6	+0.5	+0.4	+0.2	0
0.7–1.0		0	0	0	0	0	0	0	0	0	0	0
0.6		0.0382	0.0169	0.0067	0.0022	0.0006	0	0	0	0	0	0
0.5		0.1278	0.0778	0.0500	0.0328	0.0211	0.0085	0.0034	0.0008	0	0	0
0.4		0.2181	0.1467	0.1088	0.0833	0.0637	0.0357	0.0189	0.0090	0.0033	0	0
0.3		0.2923	0.2186	0.1760	0.1445	0.1191	0.0790	0.0503	0.0300	0.0148	0.0027	0
0.25		0.3256	0.2513	0.2068	0.1747	0.1465	0.1008	0.0669	0.0417	0.0224	0.0031	0
0.2		0.3560	0.2821	0.2353	0.2000	0.1685	0.1180	0.0804	0.0520	0.0304	0.0049	0
0.15		0.3860	0.3150	0.2642	0.2230	0.1870	0.1320	0.0920	0.0615	0.0384	0.0096	0

VALUES OF V2

Table 6.5 (cont)

Values of V_2 for use in the equations

r/R	P	−1.0	−0.95	−0.9	−0.8	−0.7	−0.6	−0.5	−0.4	−0.2	0
0.9–1.0		0	0.0975	0.19	0.36	0.51	0.64	0.75	0.84	0.96	1
0.85		0	0.0975	0.19	0.36	0.51	0.64	0.75	0.84	0.96	1
0.8		0	0.0975	0.19	0.36	0.51	0.64	0.75	0.84	0.96	1
0.7		0	0.0975	0.19	0.36	0.51	0.64	0.75	0.84	0.96	1
0.6		0	0.0965	0.1885	0.3585	0.5110	0.6415	0.7530	0.8426	0.9613	1
0.5		0	0.0950	0.1865	0.3569	0.5140	0.6439	0.7580	0.8456	0.9639	1
0.4		0	0.0905	0.1810	0.3500	0.5040	0.6353	0.7525	0.8415	0.9645	1
0.3		0	0.0800	0.1670	0.3360	0.4885	0.6195	0.7335	0.8265	0.9583	1
0.25		0	0.0725	0.1567	0.3228	0.4740	0.6050	0.7184	0.8139	0.9519	1
0.2		0	0.0640	0.1455	0.3060	0.4535	0.5842	0.6995	0.7984	0.9446	1
0.15		0	0.0540	0.1325	0.2870	0.4280	0.5585	0.6770	0.7805	0.9360	1

r/R	P	+1.0	+0.95	+0.9	+0.85	+0.8	+0.7	+0.6	+0.5	+0.4	+0.2	0
0.9–1.0		0	0.0975	0.1900	0.2775	0.3600	0.51	0.6400	0.75	0.8400	0.9600	1
0.85		0	0.1000	0.1950	0.2830	0.3660	0.5160	0.6455	0.7550	0.8450	0.9615	1
0.8		0	0.1050	0.2028	0.2925	0.3765	0.5265	0.6545	0.7635	0.8520	0.9635	1
0.7		0	0.1240	0.2337	0.3300	0.4140	0.5615	0.6840	0.7850	0.8660	0.9675	1
0.6		0	0.1485	0.2720	0.3775	0.4620	0.6060	0.7200	0.8090	0.8790	0.9690	1
0.5		0	0.1750	0.3056	0.4135	0.5039	0.6430	0.7478	0.8275	0.8880	0.9710	1
0.4		0	0.1935	0.3235	0.4335	0.5220	0.6590	0.7593	0.8345	0.8933	0.9725	1
0.3		0	0.1890	0.3197	0.4265	0.5130	0.6505	0.7520	0.8315	0.8020	0.9750	1
0.25		0	0.1758	0.3042	0.4108	0.4982	0.6359	0.7415	0.8259	0.8899	0.9751	1
0.2		0	0.1560	0.2840	0.3905	0.4777	0.6190	0.7277	0.8170	0.8875	0.9750	1
0.15		0	0.1300	0.2600	0.3665	0.4520	0.5995	0.7105	0.8055	0.8825	0.9760	1

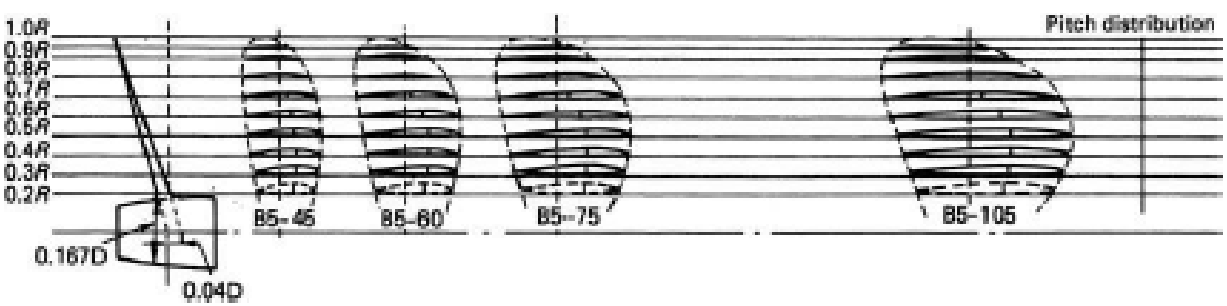


Figure 6.11 General plan of B5-screw series (Reproduced with permission from Reference 6)

HUB AND SHAFT DIAMETER

Assume Hub Diameter Ratio: 0.2

B 3.35 Bp-δ CHART

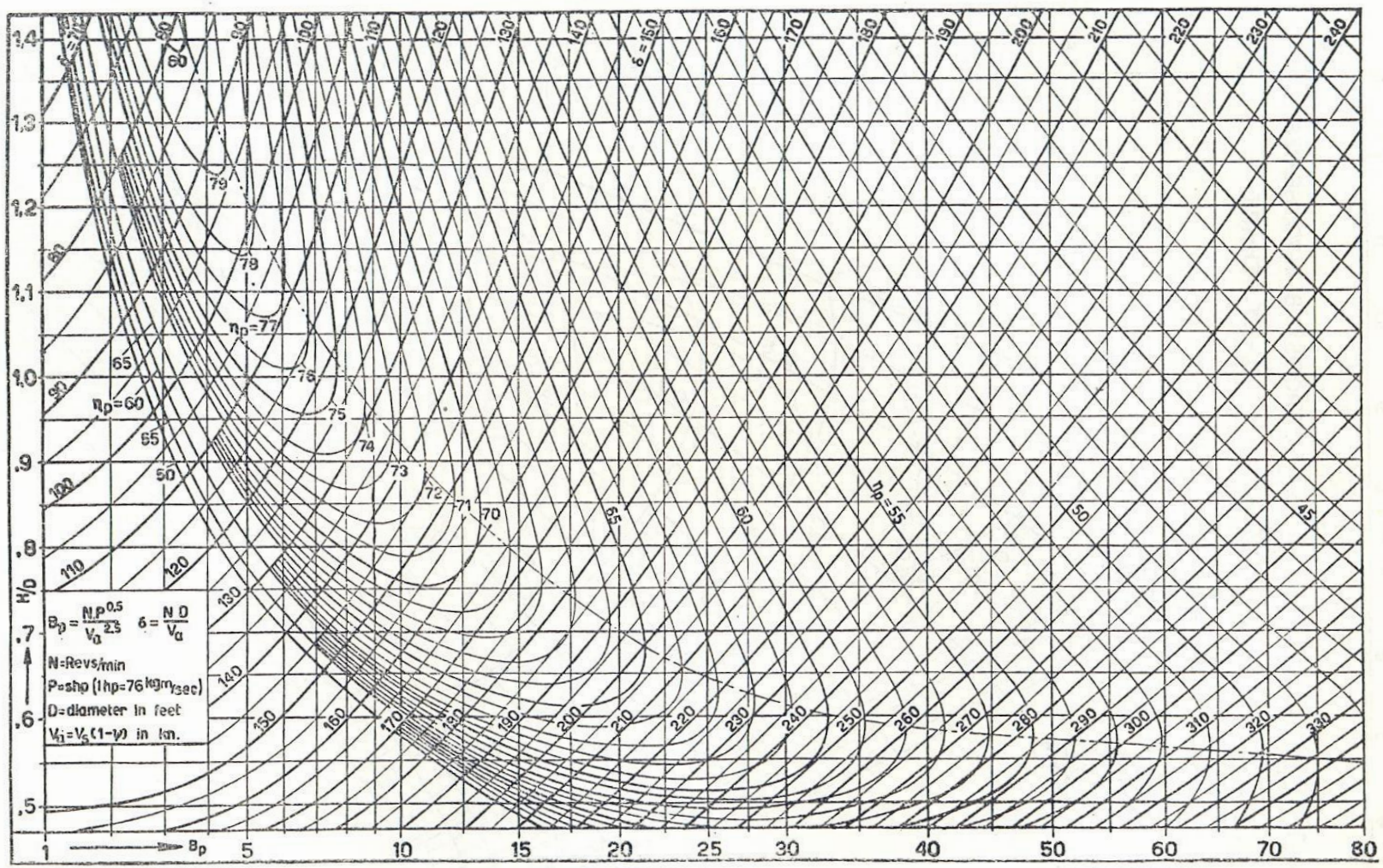


Fig. 3.12 Troost B.3 – 35 *Bp* – δ Chart

B 3.50 BP-δ CHART

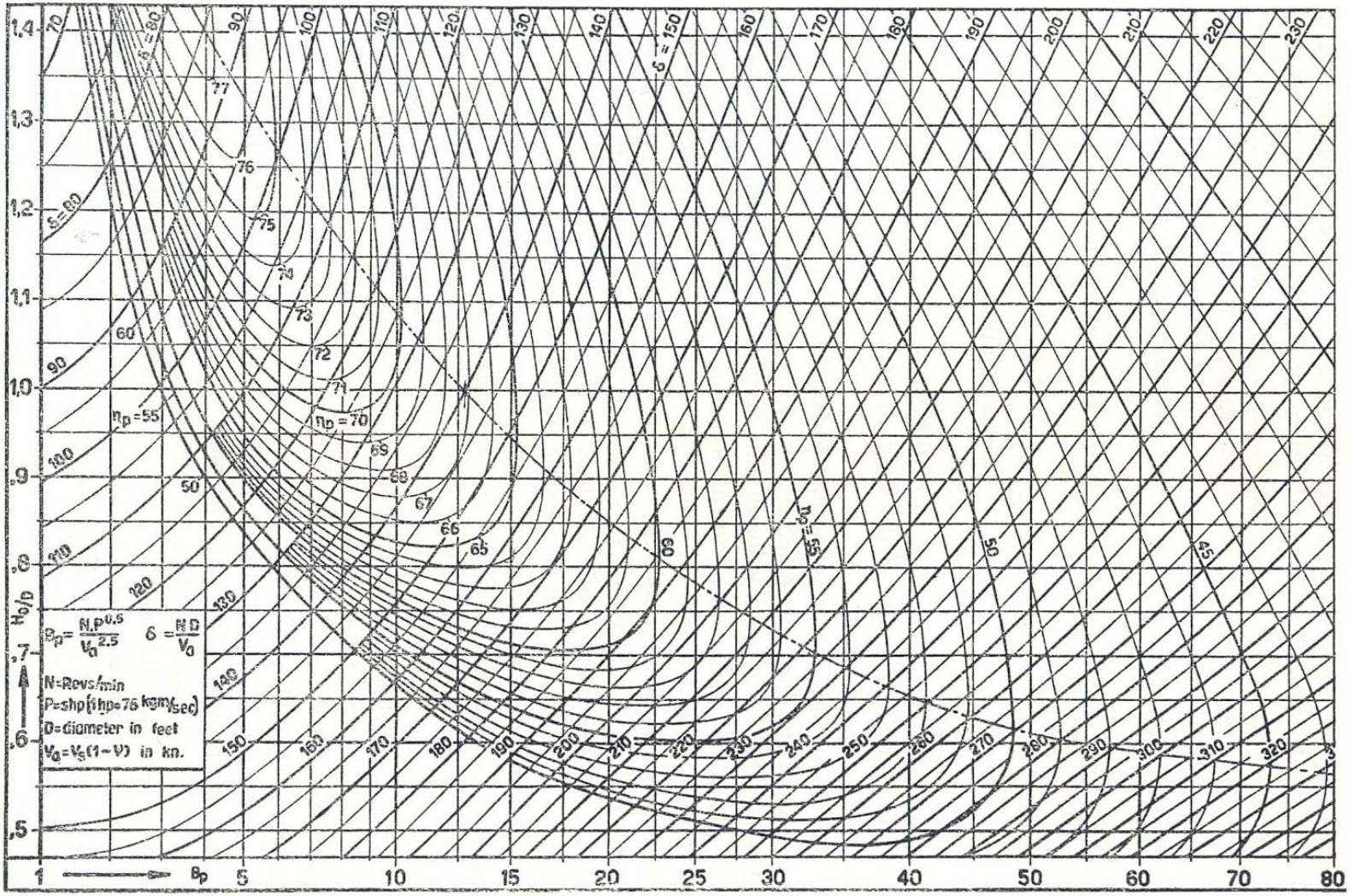


Fig. 3.13 Troost B.3 – 50 *Bp* – δ Chart

B 3.65 Bp-δ CHART

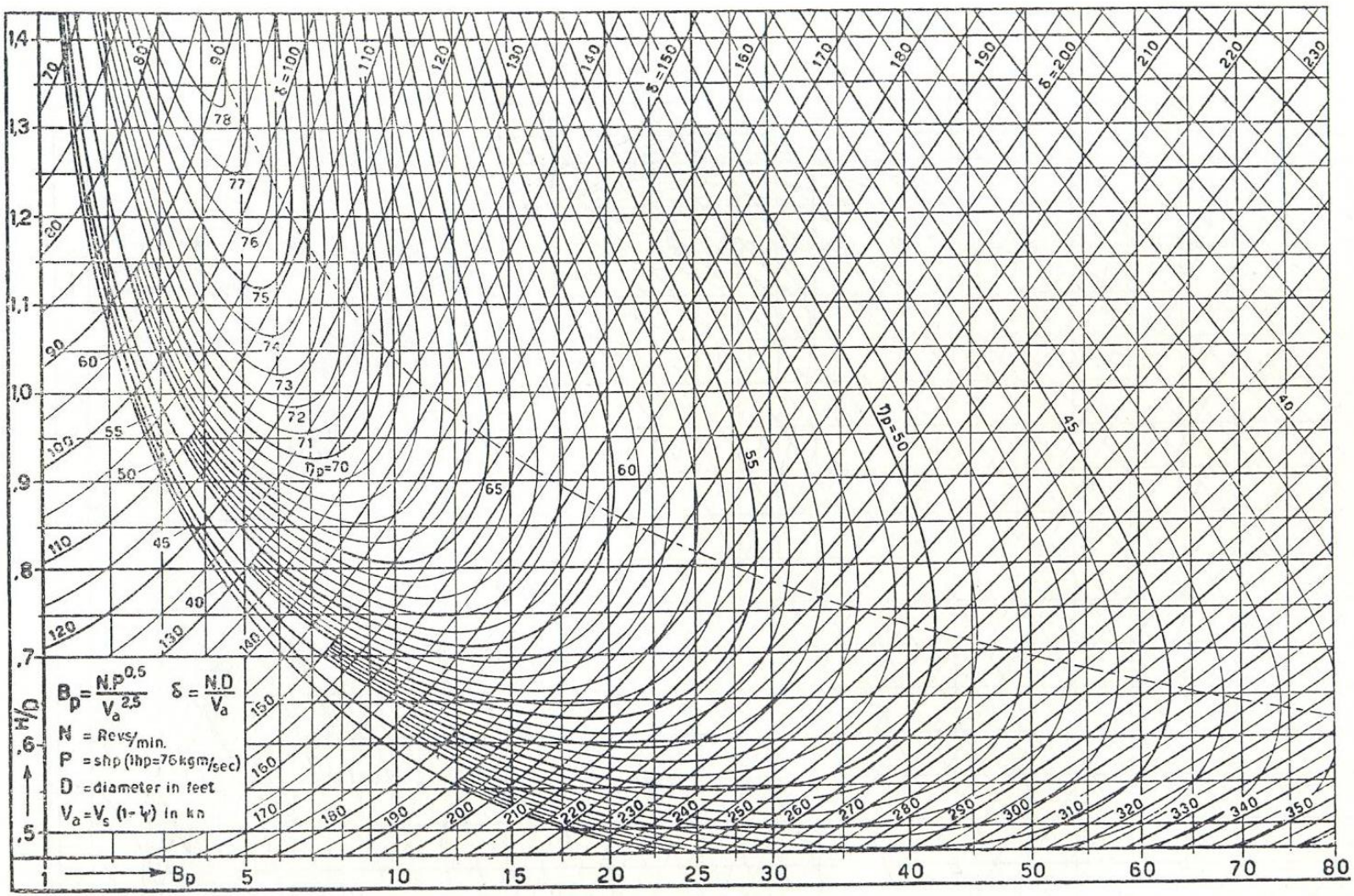


Fig. 3.14 Troost B.3 – 65 *Bp* – δ Chart

B 4.40 Bp-δ CHART

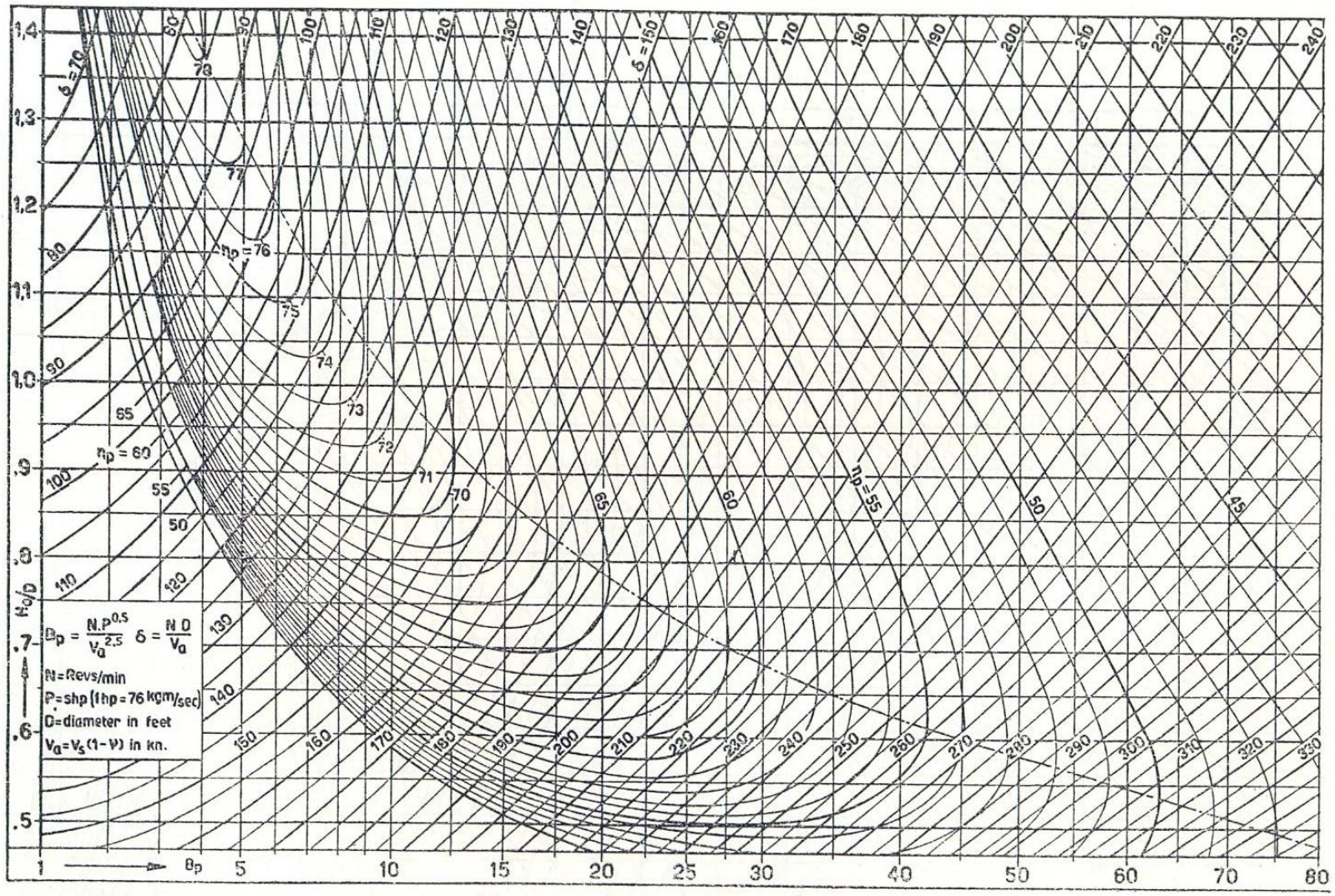


Fig. 3.15 Troost B.4 – 40 *Bp* – δ Chart

B 4.55 Bp-δ CHART

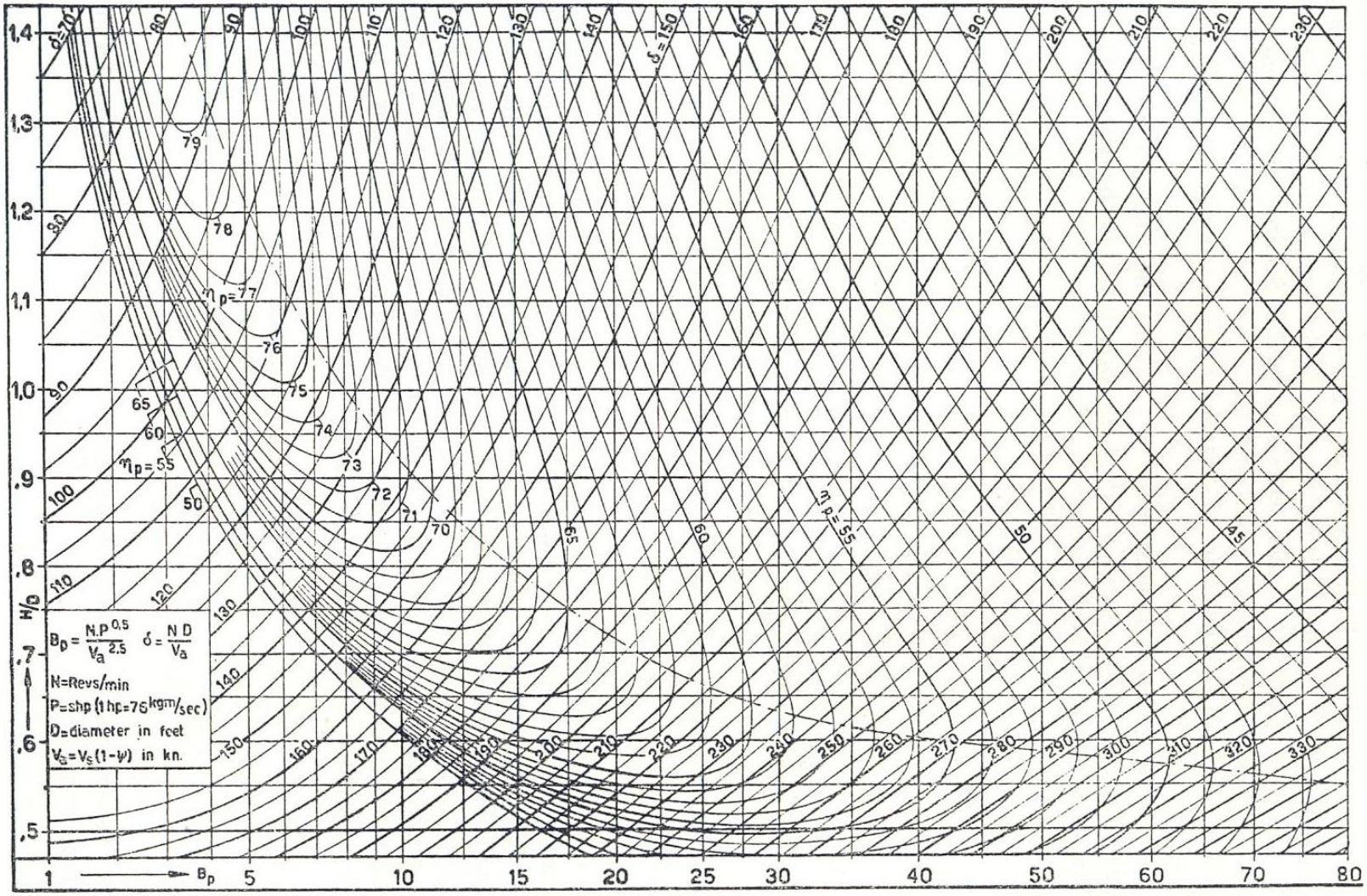


Fig. 3.16 Troost B.4 – 55 *Bp* – δ Chart

B 4.70 Bp-δ CHART

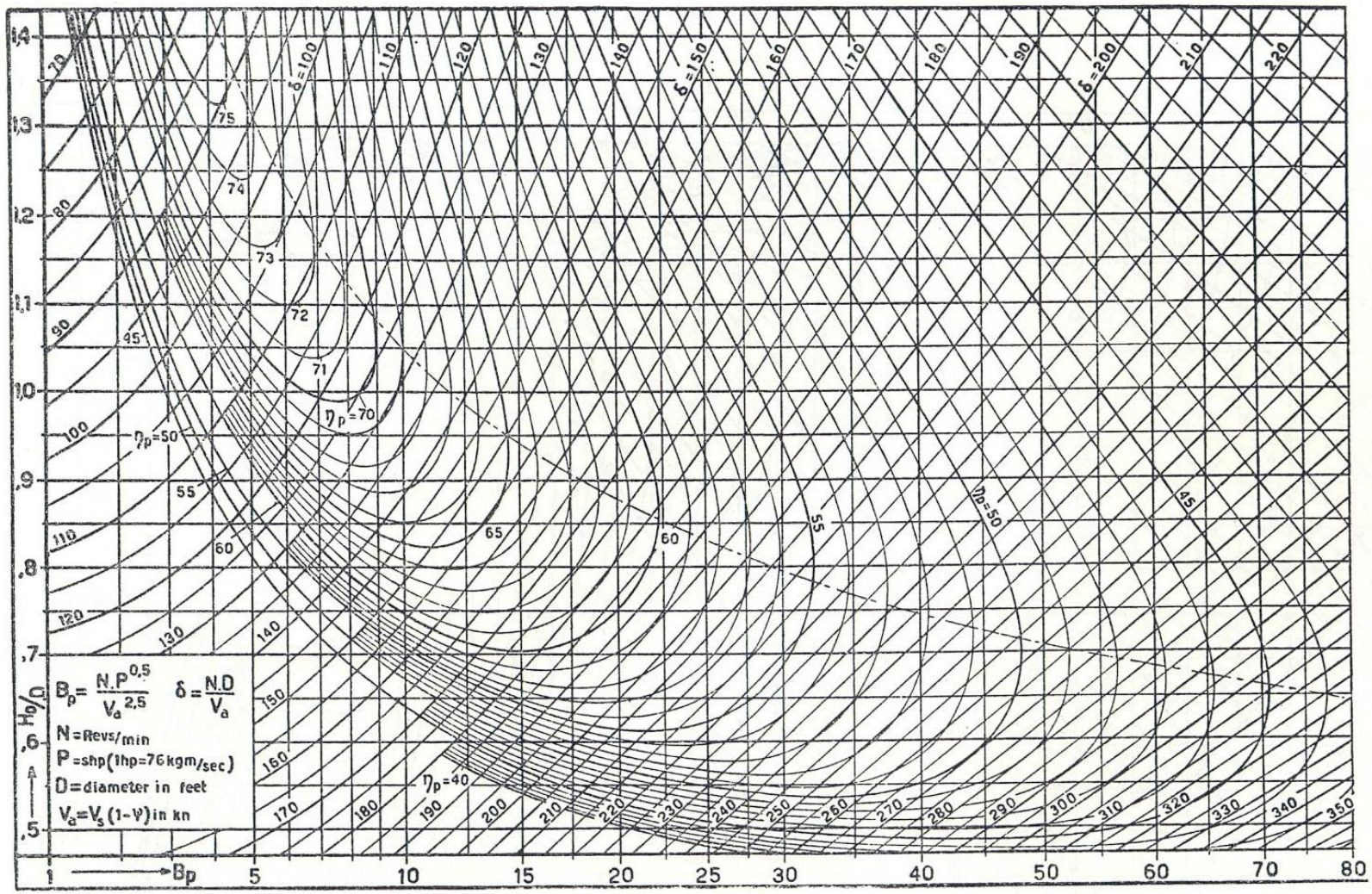


Fig. 3.17 Troost B.4 – 70 *Bp* – δ Chart

B 5.45 Bp-δ CHART

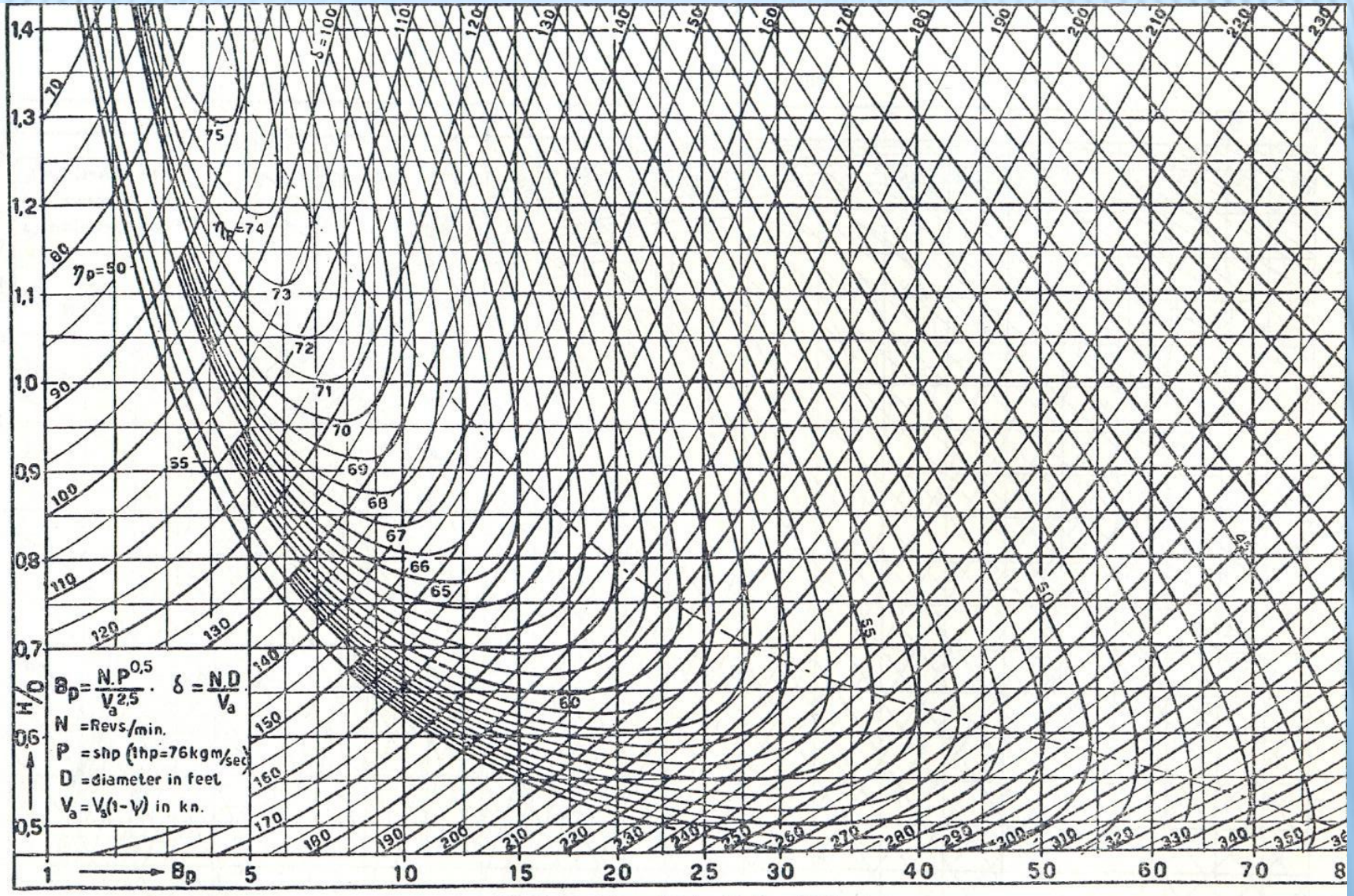


Fig. 3.18 Troost B.5 – 45 *Bp* – δ Chart

B 5.60 Bp-δ CHART

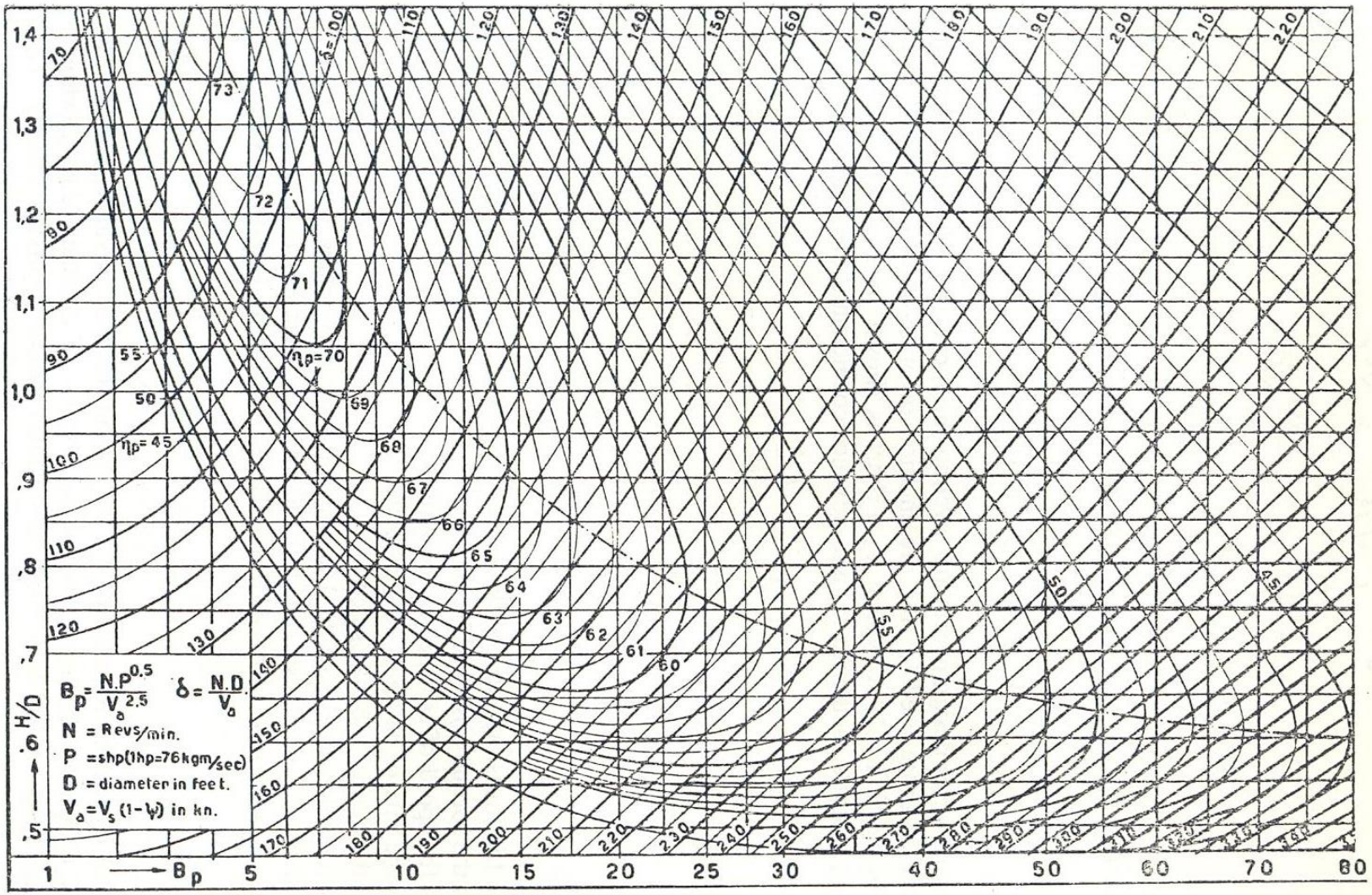
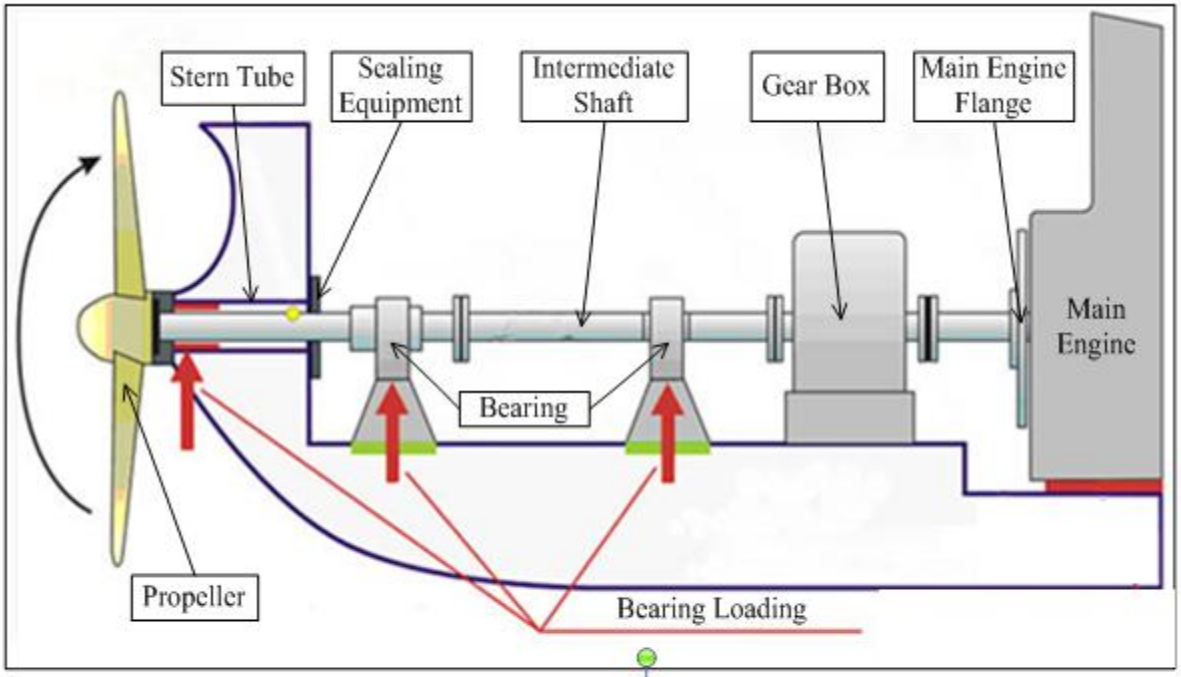


Fig. 3.19 Troost B.5 – 60 *Bp* – δ Chart



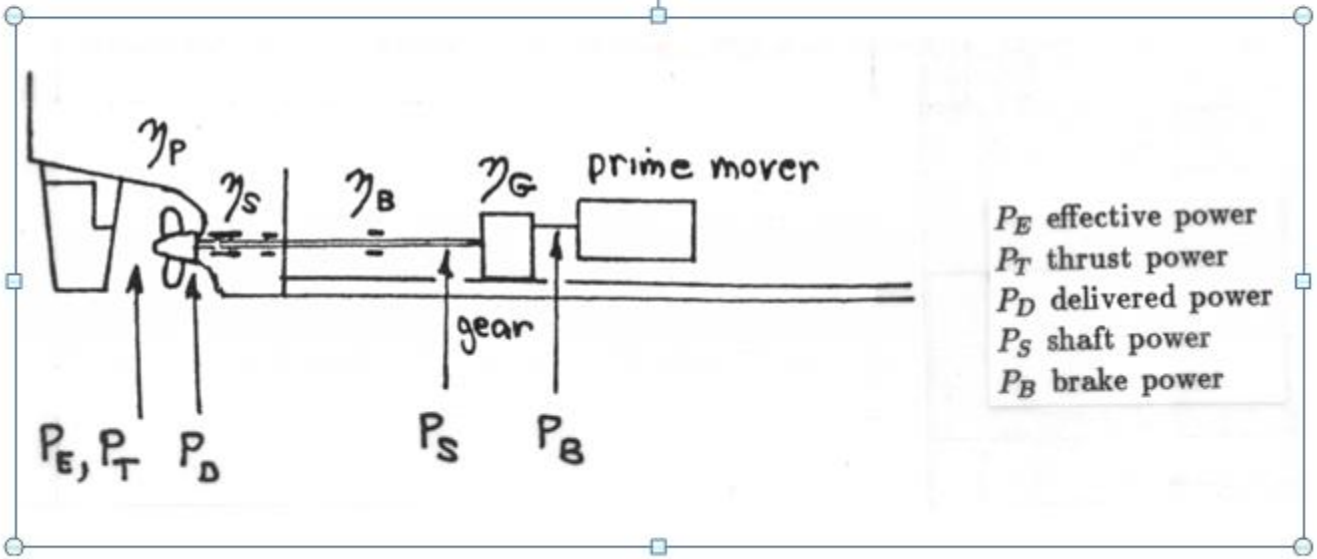


Fig.: Ship Power Definition

HULL EFFICIENCY

$$T(1-t) = R$$

$$TV(1-t) = R.V$$

$$T\frac{V_A}{(1-W_t)}.(1-t) = R.V$$

$$THP\frac{(1-t)}{(1-W_t)} = EHP$$

$$\frac{(1-t)}{(1-W_t)} = \frac{EHP}{THP} = Hull\ efficiency = \eta_H$$

R = Towrope resistance of the hull

T= Thrust of the propeller

Txt = Thrust deduction

t = thrust deduction fraction

1-t = thrust deduction fraction

$T.V_A$ = Thrust power (THP)

R.V = Effective power (EHP)

V_A = Speed of Advance V_S (1-w_t)

V =VA/(1-wt)

Wt = Taylor wake fraction

SHAFT POWER, Ps

$$\eta_D = \eta_o \eta_R \eta_H$$

$$J = \frac{V_A}{nD}$$

$$QPC = \eta_D \eta_S$$

$$P_S = \frac{P_E}{QPC} = \frac{R.V_S}{QPC}$$

CAVITATION CHECK:

The local Cavitation number at 0.7R is given by:

$$\sigma_{0.7R} = \frac{p_A - p_v + \rho g h}{\frac{1}{2}\rho\left[V_A^2 + (0.7\pi n D)^2\right]}$$

An approximate value for which is given by:

$$\sigma_{0.7R} = \frac{188.2 + 19.62h}{V_A^2 + 4.836n^2D^2},$$

A mean thrust loading coefficient given by the following expression

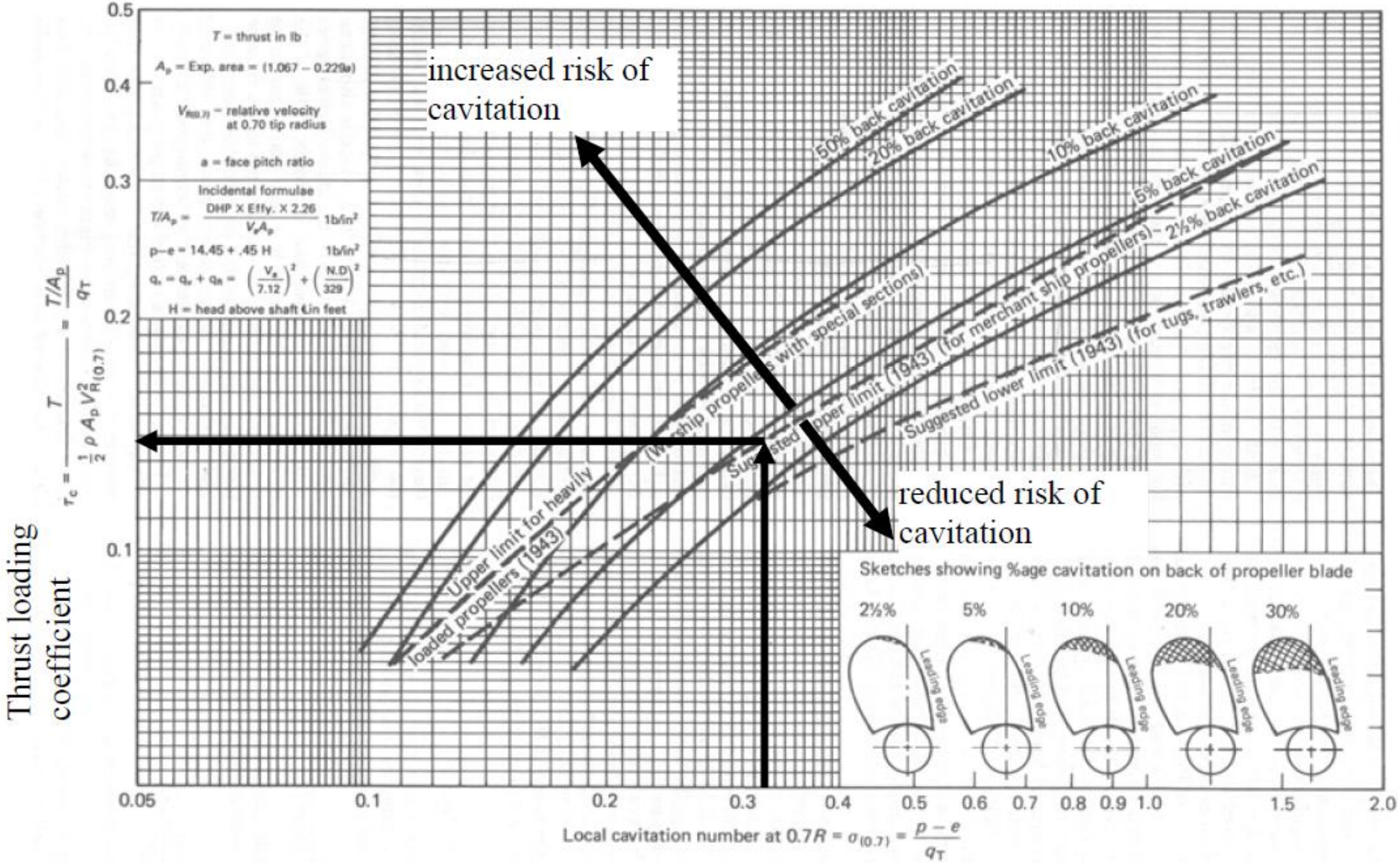
$$\tau_c = \frac{T/A_P}{\frac{1}{2}\rho V_R^2}$$

is then obtained from Burril cavitation chart and AP is calculated. From following expression, AD is calculated

$$\frac{A_P}{A_D} = 1.067 - 0.229\frac{P}{D}$$

And finally minimum expanded blade area ratio (EAR) required is calculated assuming AD~AE

BURRIL CAVITATION CHART



EAR

$$A_E \cong \frac{A_P}{(1.067 - 0.229\,P/D)}$$

Assuming AE=AD

Expanded blade area ratio, EAR

$$\frac{A_E}{A_0} = \frac{A_E}{\pi D^2 / 4}$$

KELLER'S CRITERION FOR AVOIDING CAVITATION

The alternative blade area estimation is the Keller Formula as

$$\frac{A_E}{A_0} = \frac{(1.3 + 0.3Z)T}{(P_0 - P_V)D^2} + K$$

where P_0 is the static pressure at the shaft C_L in Pa

P_V is the vapour pressure in Pa (~1700 N/m^2)

T is the propeller thrust (N)

Z is the number of blades

D is the propeller diameter in meters

The value of K varies with the number of propellers and ship types as:

K=0.2	for single screws	
K=0.0	for fast naval ships	}Twin screws
K=0.1	for slow merchant ships	

DIA, PITCH & RPM OF 3 BLADED PROPELLER

ASSUME Pressure Loading of 80kN/m.m

$T = R/(1-t)$

$V_A = V_S(1-w)$

AREA OF BLADES $A_D = T/80$

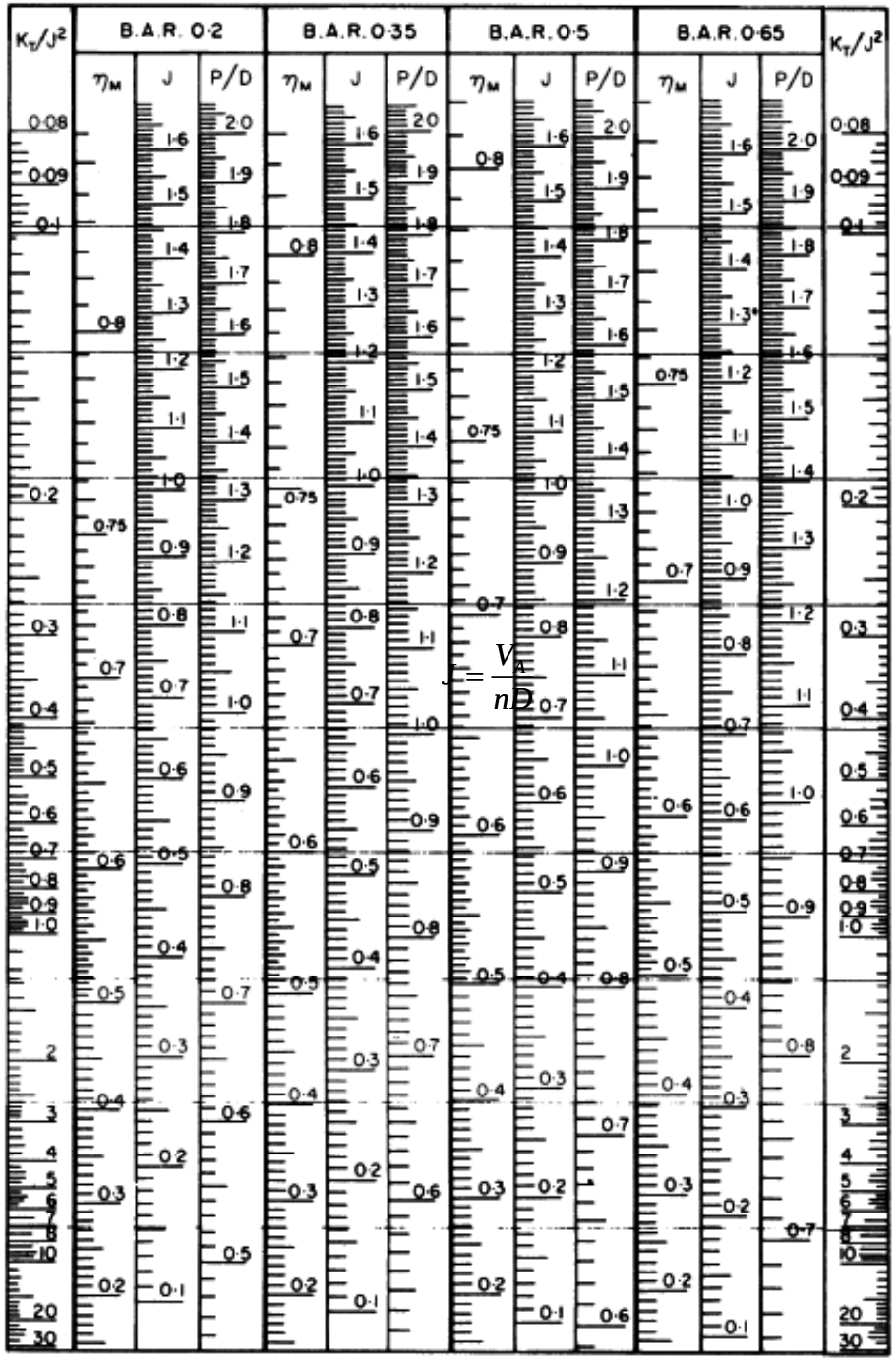
BAR $= 4.A_D/(\pi D.D)$

D =?

$$\frac{K_T}{J^2} = \frac{T}{\rho n^2 D^4} / \frac{V_A^2}{n^2 D^2} = \frac{T}{\rho D^2 V_A^2}$$

Use $\frac{K_T}{J^2}$ Chart and determine P/D, J and η

Number of blade = 3



P/D=?

P=?

Speed of Advance,

$$J = \frac{V_A}{nD}$$

n =?

http://teacher.buet.ac.bd/mmkarim/

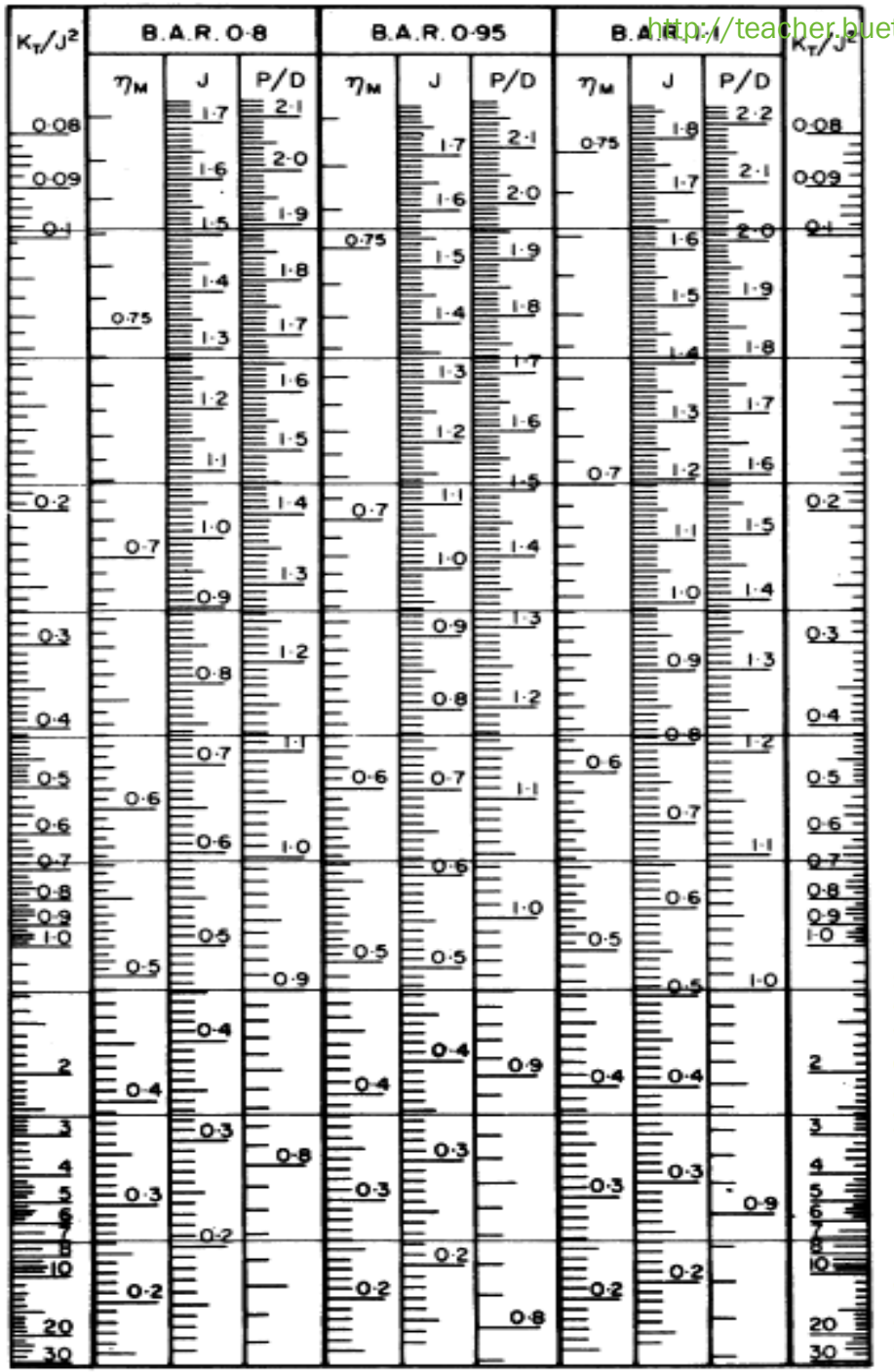


Diagram gives the maximum peller efficiency, η_M, obtainable any known value of K_T/J^2 corresponding values of advance efficient J and pitch ratio

$$\frac{K_T}{J^2} = \frac{36.13}{D^2 V^2} T$$

$$J = \frac{30.88}{nD}$$

where T = thrust in tonnef
D and P are in metres
n is in r.p.m.
V is in knots

NUMBER OF BLADES OTHER THAN THREE

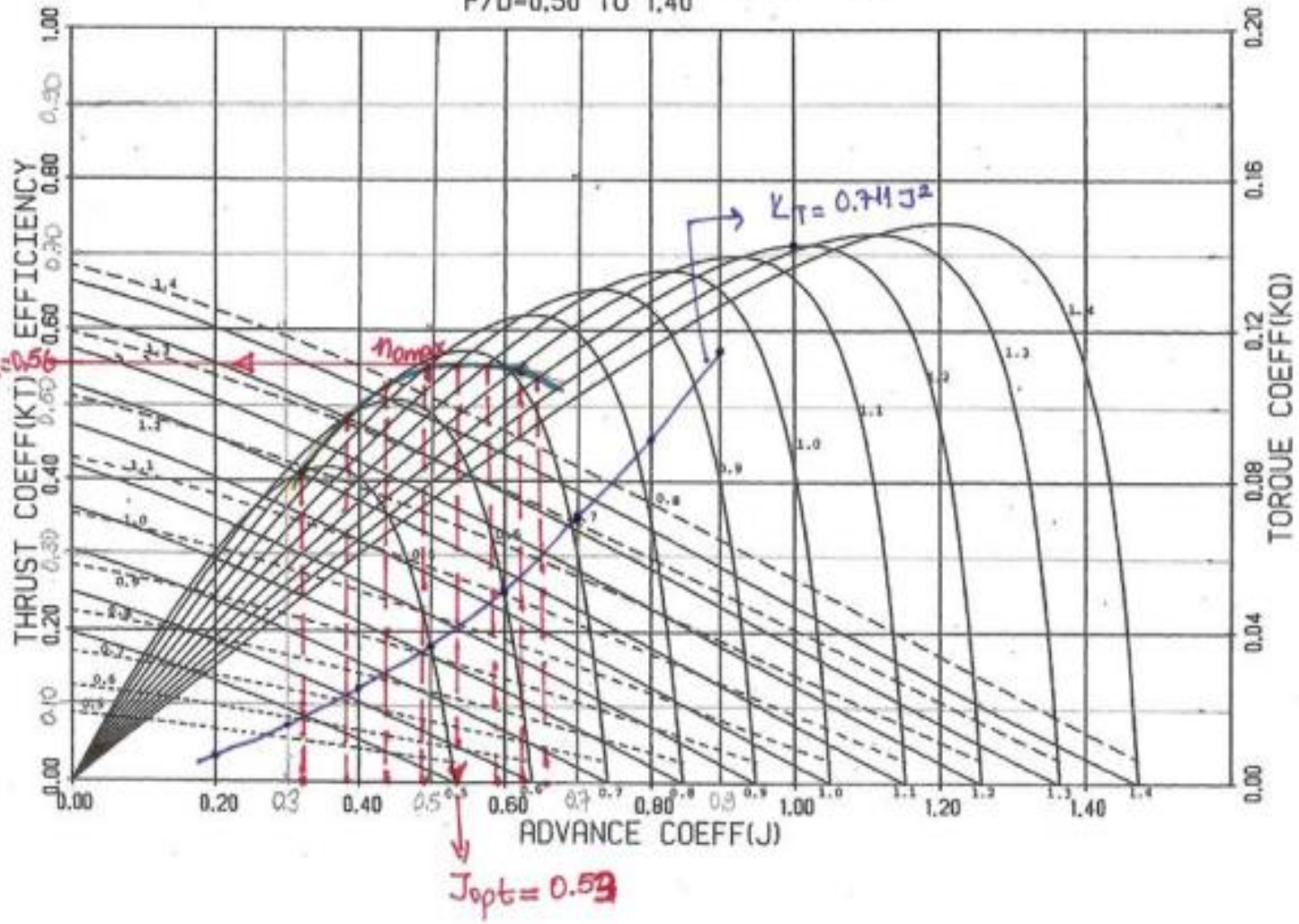
Obtain values of $\frac{K_T}{J^2}$

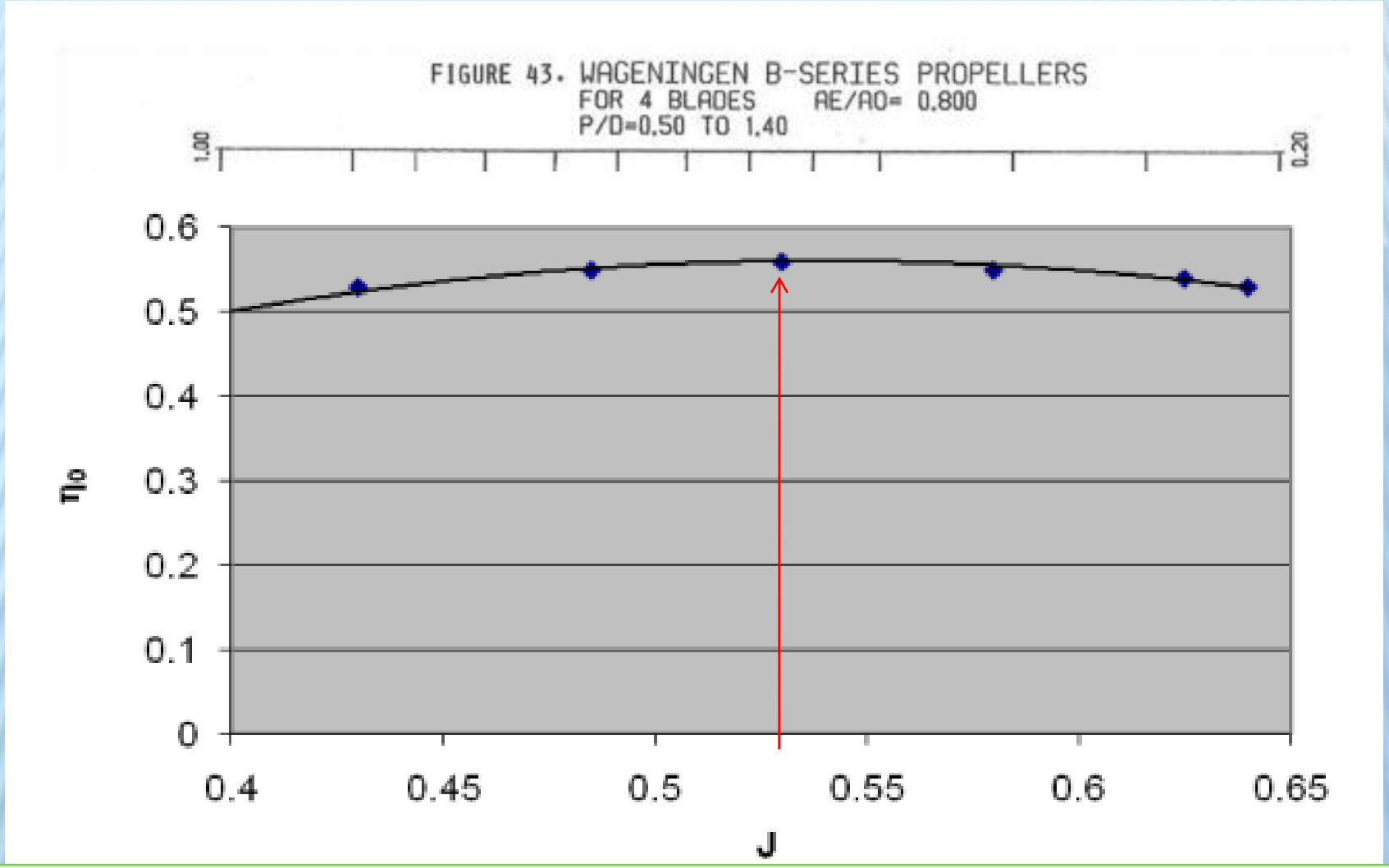
Prepare a table as follows:

J	$\frac{K_T}{J^2} \times J^2$
0.4	?
0.5	?
0.6	?
0.7	?
...	?

Plot these data on a *KT-KQ-Eta-J* diagram and find the intersection points with *KT* curve. Draw perpendicular at these points and obtain *eta* for different *j* values and finally plot it.

FIGURE 43. WAGENINGEN B-SERIES PROPELLERS
FOR 4 BLADES AE/AO= 0.800
P/D=0.50 TO 1.40





The advance coefficient at which eta is maximum is the optimum operating condition. From Jopt, find the optimum rpm of propeller.

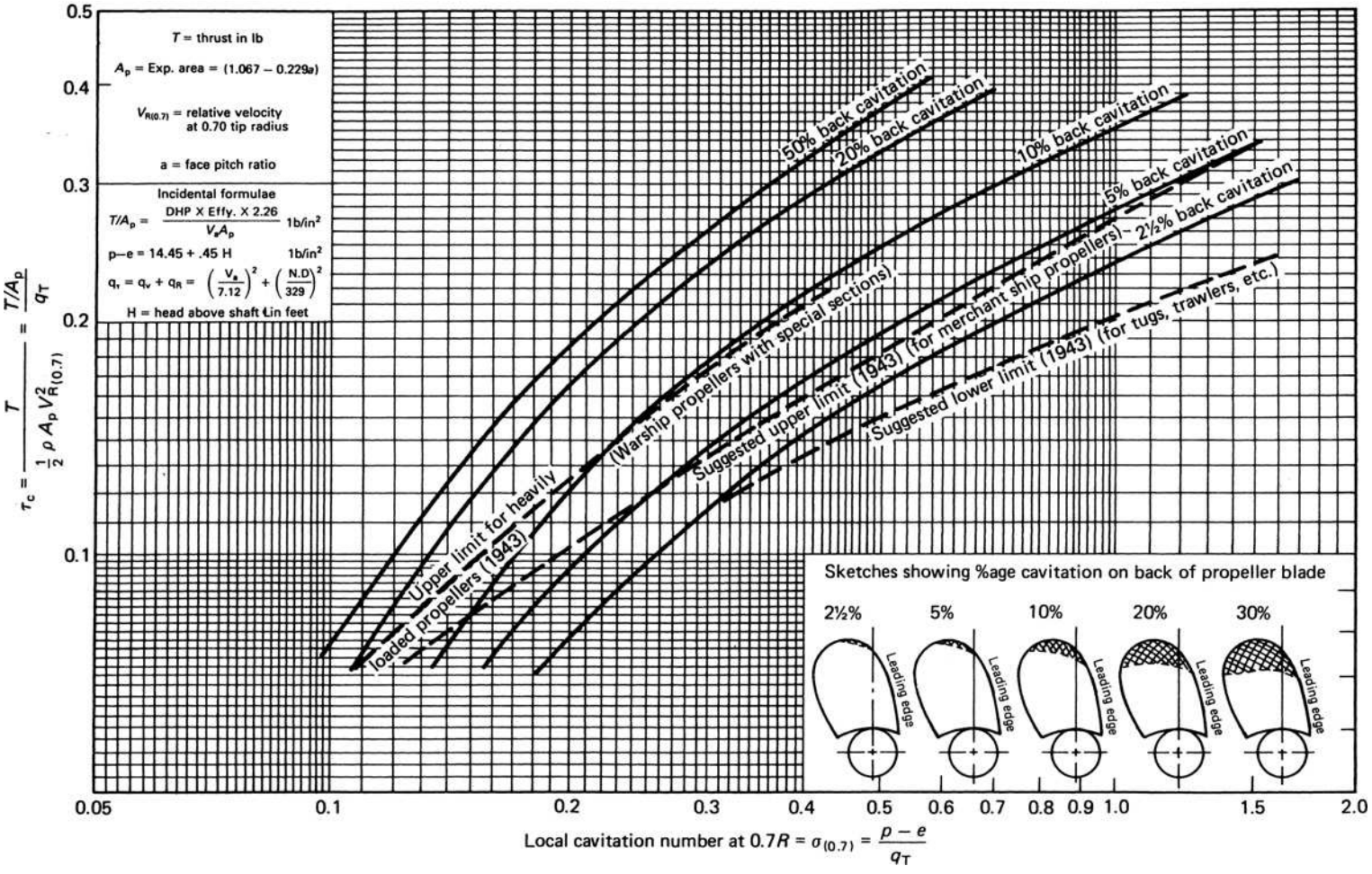


Figure 9.18 Burrill cavitation diagram for uniform flow (Reproduced from Reference 22)

Diameter propeller(m)		3,35	=	3350,0000	mm	Hasil skala	167,5
Jari-jari (m)		1,675	=	1675,0000	mm	Hasil skala	83,75
		0,335					
Panjang Blade elemen		0.85/0.4*0,2187					
untuk Fa/F	0,85	1,556870625	=	1556,8706	mm	Hasil skala	77,84353125
Ketebalan maksimum(St)		0.045xD					
		0,15075	=	150,7500	mm	Hasil skala	7,5375
Skala keseluruhan		1:20					

Jarak garis bagi jari-jari :

r/R	Jarak (m)	mm	Skala 1:20
0,2	0,33500000	335,00000	16,750000
0,3	0,50250000	502,50000	25,125000
0,4	0,67000000	670,00000	33,500000
0,5	0,83750000	837,50000	41,875000
0,6	1,00500000	1005,00000	50,250000
0,7	1,17250000	1172,50000	58,625000
0,8	1,34000000	1340,00000	67,000000
0,9	1,50750000	1507,50000	75,375000
1	1,67500000	1675,00000	83,750000

Center line ke Trailing Edge

r/R	L 0.6 R (mm)	Konstanta	Ordinat (mm)	Skala 1:20 (mm)
0,2	1556,870625	29,18%	454,2948484	22,71474242
0,3	1556,870625	33,32%	518,7492923	25,93746461
0,4	1556,870625	37,30%	580,7127431	29,03563716
0,5	1556,870625	40,78%	634,8918409	31,74459204
0,6	1556,870625	43,92%	683,7775785	34,18887893
0,7	1556,870625	46,68%	726,7472078	36,33736039
0,8	1556,870625	48,35%	752,7469472	37,63734736
0,9	1556,870625	47,00%	731,7291938	36,58645969
1	1556,870625	20,14%	313,5537439	15,67768719

Center line ke Leading Edge

r/R	L 0,6 R (mm)	Konstanta	Ordinat (mm)	Skala 1:20
0,2	1556,870625	46,90%	730,1723231	36,50861616
0,3	1556,870625	52,64%	819,536697	40,97683485
0,4	1556,870625	56,32%	876,829536	43,8414768
0,5	1556,870625	57,60%	896,75748	44,837874
0,6	1556,870625	56,08%	873,0930465	43,65465233
0,7	1556,870625	51,40%	800,2315013	40,01157506
0,8	1556,870625	41,65%	648,4366153	32,42183077
0,9	1556,870625	25,35%	394,6667034	19,73333517
1	1556,870625	0,00%	0	0

Panjang elemen total

r/R	L 0.6 R	Konstanta	Ordinat (mm)	Skala 1 : 20
0,2	1556,870625	76,08%	1184,467172	59,22335858
0,3	1556,870625	85,96%	1338,285989	66,91429946
0,4	1556,870625	93,62%	1457,542279	72,87711396
0,5	1556,870625	98,38%	1531,649321	76,58246604
0,6	1556,870625	100%	1556,870625	77,84353125
0,7	1556,870625	98,08%	1526,978709	76,34893545
0,8	1556,870625	90,00%	1401,183563	70,05917813
0,9	1556,870625	72,35%	1126,395897	56,31979486
1	1556,870625	0,00%	0	0,00000000

Ketebalan maksimum blade tiap elemen

r/R	Konstanta (%D)	Ordinat (mm)	Skala 1:20
0,2	3,66%	122,6100000	6,1305
0,3	3,24%	108,5400000	5,427
0,4	2,82%	94,4700000	4,7235
0,5	2,40%	80,4000000	4,02
0,6	1,98%	66,3300000	3,3165
0,7	1,56%	52,2600000	2,613
0,8	1,14%	38,1900000	1,9095
0,9	0,72%	24,1200000	1,206
1	0,30%	10,0500000	0,5025

Jarak ordinat Tebal maksimum dari Leading Edge

r/R	Konstanta (%D)	Ordinat(mm)	Skala 1:20		
0,2	35,0%	414,56351	20,7281755	4,145635100	7,699037
0,3	35,0%	468,400096	23,42000481	4,684000962	8,698859
0,4	35,0%	510,139798	25,50698988	5,101397977	9,474025
0,5	35,5%	543,735509	27,18677545	5,437355089	9,879138
0,6	38,9%	605,622673	30,28113366	6,056226731	9,51248
0,7	44,3%	676,451568	33,8225784	6,764515681	8,505271
0,8	47,9%	671,166926	33,55834632	6,711669264	7,300166
0,9	50,0%	563,197949	28,15989743	5,631979486	5,631979

DISTRIBUSI PITCH

Ho/D	=	0,76					
Ho	=	2,546	m	Skala 1:20	=	127,3	mm
Ho/2π	=	0,405414013	m	Skala 1:20	=	20,27070064	mm

Distribusi Pitch

r/R	Konstanta (%D)	Ordinat (mm)	Skala
0,2	82,20%	333,250318	16,66251592
0,3	88,70%	359,602229	17,98011146
0,4	95,00%	385,143312	19,25716561
0,5	99,20%	402,170701	20,10853503
0,6	100,00%	405,414013	20,27070064
0,7	100,00%	405,414013	20,27070064
0,8	100,00%	405,414013	20,27070064
0,9	100,00%	405,414013	20,27070064

JARAK ORDINAT TEBAL PROPELLER DARI ORDINAT MAKSIMUM

Tebal maksimum x %Ordinat

Ordinat Back Trailing Edge

r/R	20%	Ordinat(mm)	40%	Ordinat(mm)	60%	Ordinat(mm)	80%	Ordinat(mm)
0,2	96,45%	118,257345	86,90%	106,54809	72,65%	89,076165	53,35%	65,412435
0,3	96,80%	105,06672	86,80%	94,21272	71,60%	77,71464	50,95%	55,30113
0,4	97,00%	91,6359	86,55%	81,763785	70,25%	66,365175	47,70%	45,06219
0,5	96,95%	77,9478	86,10%	69,2244	68,40%	54,9936	43,40%	34,8936
0,6	96,80%	64,20744	85,40%	56,64582	67,15%	44,540595	40,20%	26,66466
0,7	96,65%	50,50929	84,90%	44,36874	66,90%	34,96194	39,40%	20,59044
0,8	96,70%	36,92973	85,30%	32,57607	67,80%	25,89282	40,95%	15,638805
0,9	97,00%	23,3964	87,00%	20,9844	70,00%	16,884	45,15%	10,89018

Gambar setelah diskala

r/R	20%	Ordinat(mm)	40%	Ordinat(mm)	60%	Ordinat(mm)	80%	Ordinat(mm)
0,2	96,45%	5,91286725	86,90%	5,3274045	72,65%	4,45380825	53,35%	3,27062175
0,3	96,80%	5,253336	86,80%	4,710636	71,60%	3,885732	50,95%	2,7650565
0,4	97,00%	4,581795	86,55%	4,08818925	70,25%	3,31825875	47,70%	2,2531095
0,5	96,95%	3,89739	86,10%	3,46122	68,40%	2,74968	43,40%	1,74468
0,6	96,80%	3,210372	85,40%	2,832291	67,15%	2,22702975	40,20%	1,333233
0,7	96,65%	2,5254645	84,90%	2,218437	66,90%	1,748097	39,40%	1,029522
0,8	96,70%	1,8464865	85,30%	1,6288035	67,80%	1,294641	40,95%	0,78194025
0,9	97,00%	1,16982	87,00%	1,04922	70,00%	0,8442	45,15%	0,544509

Ordinat Back Leading edge

r/R	20%	Ordinat (mm)	40%	Ordinat (mm)	60%	Ordinat (mm)	80%	Ordinat (mm)	90%	Ordinat (mm)	95%	Ordinat (mm)
0,2	98,60%	120,89346	94,50%	115,86645	87,00%	106,6707	74,40%	91,22184	64,35%	78,899535	56,95%	69,826395
0,3	98,40%	106,80336	94,00%	102,0276	85,80%	93,12732	72,50%	78,6915	62,65%	68,00031	54,90%	59,58846
0,4	98,20%	92,76954	93,25%	88,093275	84,30%	79,63821	70,40%	66,50688	60,15%	56,823705	52,20%	49,31334
0,5	98,10%	78,8724	92,40%	74,2896	82,30%	66,1692	67,70%	54,4308	56,80%	45,6672	48,60%	39,0744
0,6	98,10%	65,06973	91,25%	60,526125	79,35%	52,632855	63,60%	42,18588	52,20%	34,62426	43,35%	28,754055
0,7	97,60%	51,00576	88,80%	46,40688	74,90%	39,14274	57,00%	29,7882	44,20%	23,09892	35,00%	18,291
0,8	97,00%	37,0443	85,30%	32,57607	68,70%	26,23653	48,25%	18,426675	34,55%	13,194645	25,45%	9,719355
0,9	97,00%	23,3964	87,00%	20,9844	70,00%	16,884	45,15%	10,89018	30,10%	7,26012	22,00%	5,3064

Gambar Setelah diskala :

r/R	20%	Ordinat (mm)	40%	Ordinat (mm)	60%	Ordinat (mm)	80%	Ordinat (mm)	90%	Ordinat (mm)	95%	Ordinat (mm)
0,2	98,60%	6,044673	94,50%	5,7933225	87,00%	5,333535	74,40%	4,561092	64,35%	3,94497675	56,95%	3,49131975
0,3	98,40%	5,340168	94,00%	5,10138	85,80%	4,656366	72,50%	3,934575	62,65%	3,4000155	54,90%	2,979423
0,4	98,20%	4,638477	93,25%	4,40466375	84,30%	3,9819105	70,40%	3,325344	60,15%	2,84118525	52,20%	2,465667
0,5	98,10%	3,94362	92,40%	3,71448	82,30%	3,30846	67,70%	2,72154	56,80%	2,28336	48,60%	1,95372
0,6	98,10%	3,2534865	91,25%	3,02630625	79,35%	2,63164275	63,60%	2,109294	52,20%	1,731213	43,35%	1,43770275
0,7	97,60%	2,550288	88,80%	2,320344	74,90%	1,957137	57,00%	1,48941	44,20%	1,154946	35,00%	0,91455
0,8	97,00%	1,852215	85,30%	1,6288035	68,70%	1,3118265	48,25%	0,92133375	34,55%	0,65973225	25,45%	0,48596775
0,9	97,00%	1,16982	87,00%	1,04922	70,00%	0,8442	45,15%	0,544509	30,10%	0,363006	22,00%	0,26532

Ordinat face Trailing Edge

r/R	20%	Ordinat (mm)	40%	Ordinat (mm)	60%	Ordinat (mm)	80%	Ordinat (mm)	100%	Ordinat (mm)
0,2	1,55%	1,900455	5,45%	6,682245	10,90%	13,36449	18,20%	22,31502	30,00%	36,783
0,3	0,00%	0	1,70%	1,84518	5,80%	6,29532	12,20%	13,24188	23,35%	25,34409
0,4	0,00%	0	0,00%	0	1,50%	1,41705	6,20%	5,85714	17,85%	16,862895
0,5	0,00%	0	0,00%	0	0,00%	0	1,75%	1,407	9,70%	7,7988
0,6	0,00%	0	0,00%	0	0,00%	0	0,00%	0	5,10%	3,38283
0,7	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0
0,8	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0
0,9	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0

Gambar setelah diskala:

r/R	20%	Ordinat (mm)	40%	Ordinat (mm)	60%	Ordinat (mm)	80%	Ordinat (mm)	100%	Ordinat (mm)
0,2	1,55%	0,09502275	5,45%	0,33411225	10,90%	0,6682245	18,20%	1,115751	30,00%	1,83915
0,3	0,00%	0	1,70%	0,092259	5,80%	0,314766	12,20%	0,662094	23,35%	1,2672045
0,4	0,00%	0	0,00%	0	1,50%	0,0708525	6,20%	0,292857	17,85%	0,84314475
0,5	0,00%	0	0,00%	0	0,00%	0	1,75%	0,07035	8,95%	0,38994
0,6	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0,1691415
0,7	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0
0,8	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0
0,9	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0

Ordinat Face Leading Edge

r/R	20%	Ordinat(mm)	40%	Ordinat(mm)	60%	Ordinat(mm)	80%	Ordinat(mm)	90%	Ordinat(mm)	95%	Ordinat(mm)	100%	Ordinat(mm)
0,2	0,45%	0,551745	2,30%	2,82003	5,90%	7,23399	13,45%	16,491045	20,30%	24,88983	26,20%	32,12382	40,00%	49,044
0,3	0,05%	0,05427	1,30%	1,41102	4,60%	4,99284	10,85%	11,77659	16,55%	17,96337	22,20%	24,09588	37,55%	40,75677
0,4	0,00%	0	0,30%	0,28341	2,65%	2,503455	7,80%	7,36866	12,50%	11,80875	17,90%	16,91013	34,50%	32,59215
0,5	0,00%	0	0,00%	0	0,70%	0,5628	4,30%	3,4572	8,45%	6,7938	13,30%	10,6932	30,40%	24,4416
0,6	0,00%	0	0,00%	0	0,00%	0	0,80%	0,53064	4,45%	2,951685	8,40%	5,57172	24,50%	16,25085
0,7	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,40%	0,20904	2,45%	1,28037	16,05%	8,38773
0,8	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	7,40%	2,82606
0,9	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0

Gambar setelah diskala

r/R	20%	Ordinat(mm)	40%	Ordinat(mm)	60%	Ordinat(mm)	80%	Ordinat(mm)	90%	Ordinat(mm)	95%	Ordinat(mm)	100%	Ordinat(mm)
0,2	0,45%	0,02758725	2,30%	0,1410015	5,90%	0,3616995	13,45%	0,82455225	20,30%	1,2444915	26,20%	1,606191	40,00%	2,4522
0,3	0,05%	0,0027135	1,30%	0,070551	4,60%	0,249642	10,85%	0,5888295	16,55%	0,8981685	22,20%	1,204794	37,55%	2,0378385
0,4	0,00%	0	0,30%	0,0141705	2,65%	0,12517275	7,80%	0,368433	12,50%	0,5904375	17,90%	0,8455065	34,50%	1,6296075
0,5	0,00%	0	0,00%	0	0,70%	0,02814	4,30%	0,17286	8,45%	0,33969	13,30%	0,53466	30,40%	1,22208
0,6	0,00%	0	0,00%	0	0,00%	0	0,80%	0,026532	4,45%	0,14758425	8,40%	0,278586	24,50%	0,8125425
0,7	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,40%	0,010452	2,45%	0,0640185	16,05%	0,4193865
0,8	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	7,40%	0,141303
0,9	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0

Radius dari hidung propeller

r/R	%D	Ordinat(mm)	Skala 1:20
0,2	0,115%	3,8525	0,192625
0,3	0,105%	3,5175	0,175875
0,4	0,095%	3,1825	0,159125
0,5	0,085%	2,8475	0,142375
0,6	0,070%	2,345	0,11725
0,7	0,055%	1,8425	0,092125
0,8	0,040%	1,34	0,067
0,9	0,040%	1,34	0,067
TIP	0,040%	1,34	0,067

Lloyd's Register of Shipping
CARGO SHIPS

DISTRIBUTION OF LIGHT-WEIGHT FOR STILL WATER BENDING MOMENT CALCULATION. (METRIC EDITION)
Rpt. SR 64/17 (March, 1964)

INTRODUCTION

To ensure consistency in the calculation of still water bending moments, whether carried out by manual integration, computer, or any other method, it is essential that a uniform method of light-weight distribution be adopted.

Section I of this report describes a method of obtaining a standard light-weight distribution for a dry cargo ship using total hull and machinery weights supplied by the shipbuilder.

It may also be desirable to have a reference light-weight for comparison purposes, and a method of determining this is outlined in Section II.

SECTION I

STANDARD LIGHT-WEIGHT DISTRIBUTION, GIVEN THE TOTAL HULL AND MACHINERY WEIGHTS.

The weight distribution curve is considered to be composed of:-

a. A continuous curve over the length of the ship, representing the weight to the uppermost continuous deck of steel plus a certain amount of wood and outfit appropriate to normal sections through hold spaces.

b. Local weights, which include items above the uppermost continuous deck together with local additions to the basic underdeck weights, such as increased structural weight in way of tanks, machinery space, insulation in refrigerated spaces, etc..

Procedure

Given the total light-weight, the procedure is to deduct the sum of all the local weights, distribute the remainder under a standard curve which depends on the block coefficient, and then add the correctly distributed local weights to the basic weight curve.

The local weights included in (b) are as follows:-

(1). Forecastle.
(2). Bridge.
(3). Poop.
(4). Deckhouse and masthouses.
} including wood and outfit.
(5). Wood and outfit in accommodation spaces below the uppermost continuous deck.
(6). Equipment at ends of ship.
(7). Cargo Gear.

(8). Refrigerated spaces.
(9). Deep tanks and peak tanks.
(10). Machinery space.
(11). Propeller and shafting outside machinery space.

The weights and distributions of these local items are as given below:-

(1). Forecastle

W = 0.0897 V tonnes where V = volume of forecastle in cubic metres.

This weight should be distributed as a triangle over the length of the forecastle.

Where the forecastle exceeds 0.15L in length, the distribution should be triangular for the forward 0.15L and rectangular aft of this.

(2). Bridge

W = 0.1292 V tonnes where V = volume of bridge in cubic metres.

This weight should be distributed as a rectangle over the length of the bridge.

(3). Poop

W = 0.1292 V tonnes where V = volume of poop in cubic metres.

This weight should be distributed linearly over the length of the poop, the ordinate at the poop front being four times the ordinate at the aft end.

(4). Deckhouses and Masthouses

W = 0.1185 V tonnes where V = volume of house in cubic metres.

Where there are several tiers these should be taken separately.

The weight should be distributed as a rectangle over the length of the house, or tier.

(5). Accommodation Spaces Below the Uppermost Continuous Deck.

This item includes additional wood and outfit appropriate to such spaces.

W = 0.0538 V tonnes where V = volume of space in cubic metres.

Underdeck accommodation may be divided into as large sections as possible, the weight of each section being homogeneously distributed overt its length.

(6). Equipment at Ends

This includes anchors, cables, hawsers, windlass, capstans, bollards, steering gear.

$$\text{Forward } W = \frac{43.75L^2}{10^4} \text{ tonnes} \quad \text{(where L is in metres).}$$

This weight should be distributed as a rectangle over a length of 0.02L having its centre 0.035L aft of the F.P.

$$\text{Aft } W = \frac{10.94L^2}{10^4} \text{ tonnes .}$$

This weight should be distributed as a rectangle over a length of 0.02L having its centre at the A.P.

(7). Cargo Gear

This item includes booms, winches, ropes and blocks, etc..

$$W = \left[0.008 \ \Sigma(S.W.L.)^2 + 5\ n_b\right] + 10 \quad \text{tonnes at each cargo handling position.}$$

where $\Sigma(S.W.L.)^2$ = the sum of the squares of the safe working loads of the individual derricks at that position.

n_b = number of booms at the position and should not exceed 4.

When the derricks are supported by a bridge front etc., rather than a mast or post, 10 tonnes per position should be deducted.

The weight should be distributed over a length of 0.02L at the position.

(8). Refrigerated Spaces

This includes weight of insulation, piping, ducting, etc..

W is a function of V, the net capacity of the space in cubic metres, and may be read from fig. 5(b).

The weight should be distributed homogeneously over the length of the space.

(9). Deep Tanks and Peak Tanks.

This item includes increases in scantlings in way of deep tanks and also bulkheads which exist specifically to form the tank and which would not otherwise be required as hold or machinery space bulkheads.

e.g., with cross bunkers at the forward end of the machinery space the local weight includes the forward transverse bulkhead while the after bulkhead is included in the basic underdeck hull weight as a normal transverse bulkhead.

Tunnel side tanks are included in this item, but small engine room tanks and wing tanks in bulk carriers are excluded.

$W = 0.0538\ V$ tonnes where V = capacity of tank in cubic metres.

This weight should be distributed homogeneously over the tank.

When cofferdams are fitted

$W = 0.1005\ V$ tonnes where V = capacity of tank in cubic metres.

(10). Machinery Space

This item includes machinery weight, together with additional structural weight in machinery space, funnel, etc. Due to the variety of engines and auxiliaries for similar power requirements, the machinery weight should be supplied by the builder.

$$W = W_m + [0.044L - 1.17]\ell_e \quad \text{tonnes}$$

or $$W = W_m + [0.011L + 0.73]\ell_e \quad \text{tonnes}$$ when the ship has heavy cargo or ore notation.

ℓ_e = length of engine and boiler room, if any, in metres, a mean length being taken if bulkheads are recessed.

W_m = weight of main and auxiliary machinery and boilers in service condition, uptakes, silencer, generators, pumps, compressors, piping, gratings, ladders, stores, spares, small tanks, etc., in machinery spaces, but excluding propeller, shafting outside machinery space, and funnel.

The weight should be distributed as a rectangle over the length ℓ_e.

(11). Propeller and shafting Outside Machinery Space

This item includes tunnel structure, shaft stools.

$$W = W_p + 0.67\ell_s \quad \text{tonnes for single screw ships.}$$

or $$W = W_p + 1.0\ell_s \quad \text{tonnes for twin screw ships.}$$

where

W_p = weight of propeller and shafting clear of machinery space in tonnes (This weight supplied by the builders).

ℓ_s = length of shafting from centre of propeller to the machinery space bulkhead, metres.

When the weights of propeller and shafting are given separately they should be distributed as rectangles over their respective lengths, the additional weight for tunnel structure also being distributed over the shaft length. Otherwise the total weight, W, should be distributed as a rectangle over the length ℓ_s.

Where the weight, W_p of propeller and shafting is not known, W may be estimated from the formula:

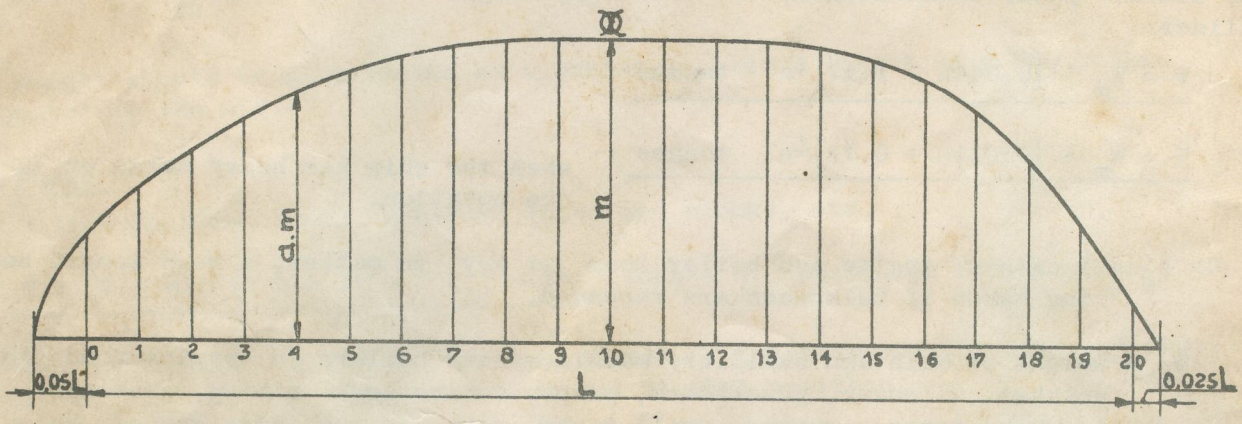
$$W = \ell_s[0.0164L + S] \quad \text{tonnes single screw.}$$

$$W = 1.5\ell_s[0.0164L + S] \quad \text{tonnes twin screw.}$$

where S is obtained from fig. 5(a).

The sum of these local weights may now be deducted from the given light-weight and the remainder distributed as follows:-

The basic weight curve has the form shown below



The ordinates of the curve are equal to a x m tonnes/metre where m is the midship ordinate and the a values are obtained from figs. 3 and 4 for the appropriate load draught block coefficient.

The area under the curve in terms of m may be found by integration, the areas aft of station 0 and forward of station 20 being taken as 0.01133mL and 0.00175mL respectively. By equating this total area to the basic weight found previously the value of m and hence the ordinates of the basic weight curve, may be determined. The local weights, distributed as indicated, can then be superimposed on the basic curve to give the required standard distribution.

SECTION II REFERENCE LIGHT-WEIGHT AND STANDARD DISTRIBUTION

In this case the hull weight is unknown and, since the total light-weight is again considered to consist of the local weights, calculated as in Section I, plus the basic underdeck weight, a value of m, maximum ordinate of the basic weight distribution curve, must be determined appropriate to the dimensions and design of the ship.

From examination of the effect of changes in various parameters on the basic underdeck weight, the following were taken to be the most important:-

Length between p.p.	- L metres
Breadth	- B metres
Depth	- D metres
Draught	- d metres
Height of hold double bottom	- h metres
Number of transverse bulkheads	- N_T (N_T includes all hold, E.R., and peak bulkheads but <u>excludes</u> bulkheads specifically fitted to form deep tanks).
Number of decks	- N_D
Block coefficient at load draught	- C_B

The ordinates of the basic underdeck weight curve are given by a x m tonnes/metre, where the a values, as before, are read from figs. 3 and 4 for the appropriate load draught block coefficient, and m is given by

$$m = 43.4 \times H \times \frac{L}{10^4} \text{ tonnes per metre}$$

where $H = C_1B + C_2D + C_3d + C_4W_oN_T + C_5 + 2.5h$

Values of, C_1, C_2, C_3, C_4 and W_o may be read from figs. 1(a) and 1(b) and values of C_5 from fig. 2.

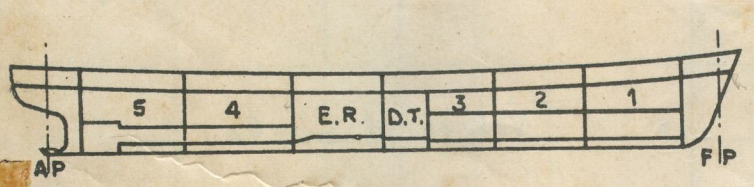
C_5 includes basic weight data for a standard ship of length L and may be corrected as indicated in NOTES for ice strengthening, strengthening for heavy cargoes or ore in alternate holds, and longitudinal bulkheads, if necessary.

The remaining terms in the expression for H take account of the actual values of the important parameters in the proposed ship, and the curves for the various C values provide automatic allowance for number of decks.

Having obtained m, the basic weight and its distribution can be readily obtained, and the local items calculated and distributed as shown in Section I may be superimposed to give the total reference light-weight and its distribution.

NOTES - FIG. 1 AND 2.

N_D is the number of decks. When there is a partical deck, its length as a proportion of L is taken. A platform deck forming the top of the shaft tunnel and wing tanks is not counted as a deck (see "deeptanks"). Parts of decks outside the perpendiculars are disregarded.



Example: $N_D = 2.38$, $N_T = 7$

N_T is the number of bulkheads excluding those fitted to form deep tanks.
h is the depth of double bottom in holds

Additions to C_5:

When strengthened for heavy cargoes . . . . . 3,75 W_o

When ore is carried in alternate holds . . . . . 4,50 W_o

When strengthened for navigation in ice . . . . . C_6 W_o

Where

Ice class	1	2	3
C_6	8,0	4,0	1,6

When longitudinal bulkheads are fitted . . . . . $11(\ell/L)W_o$
Where ℓ = total length of bulkheads extending over the full depth of ship.

Values of W_o

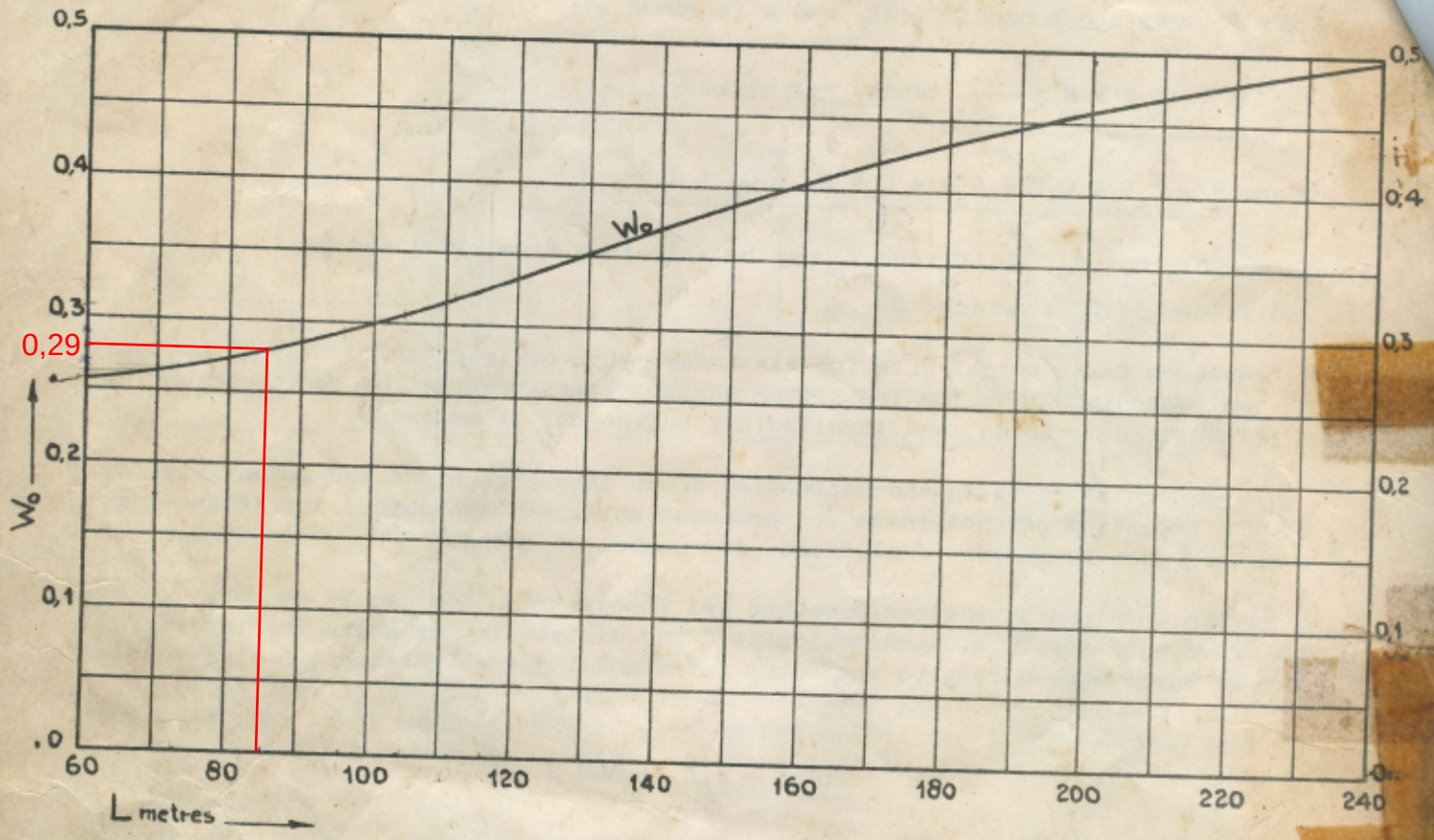
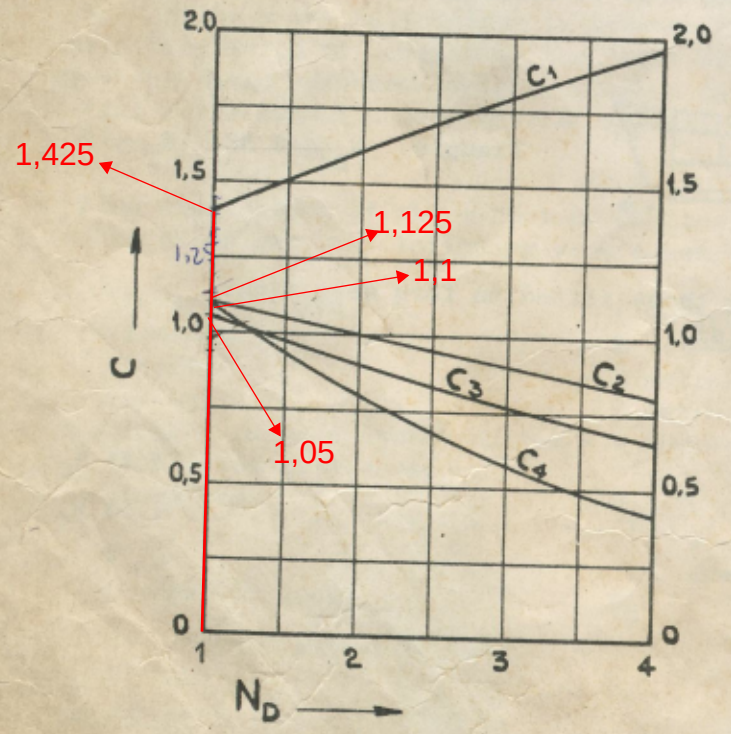
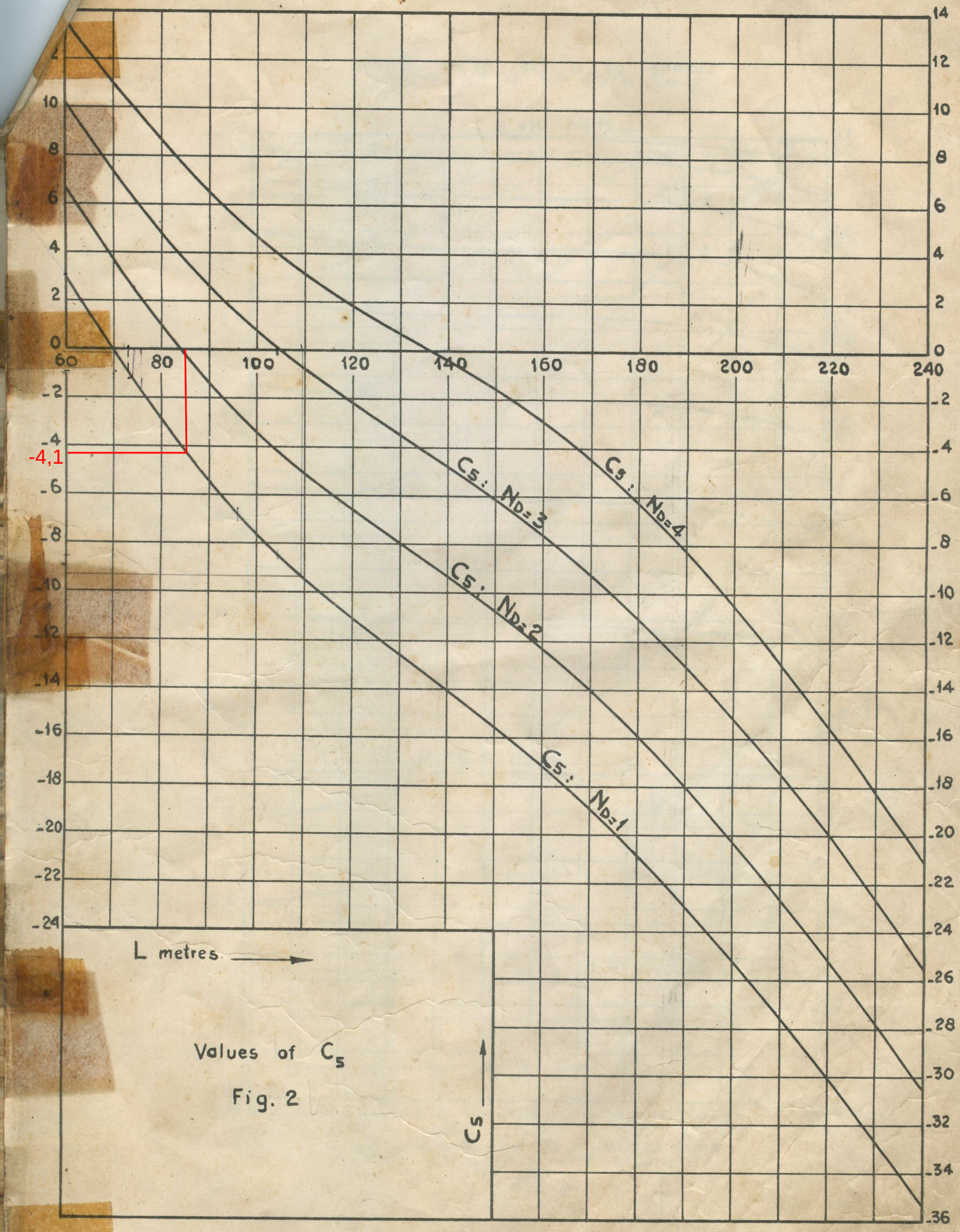


Fig. 1 (a)



Values of C_1 to C_4

Fig. 1 (b)



Values of C_5

Fig. 2

Values of „a" for After Body

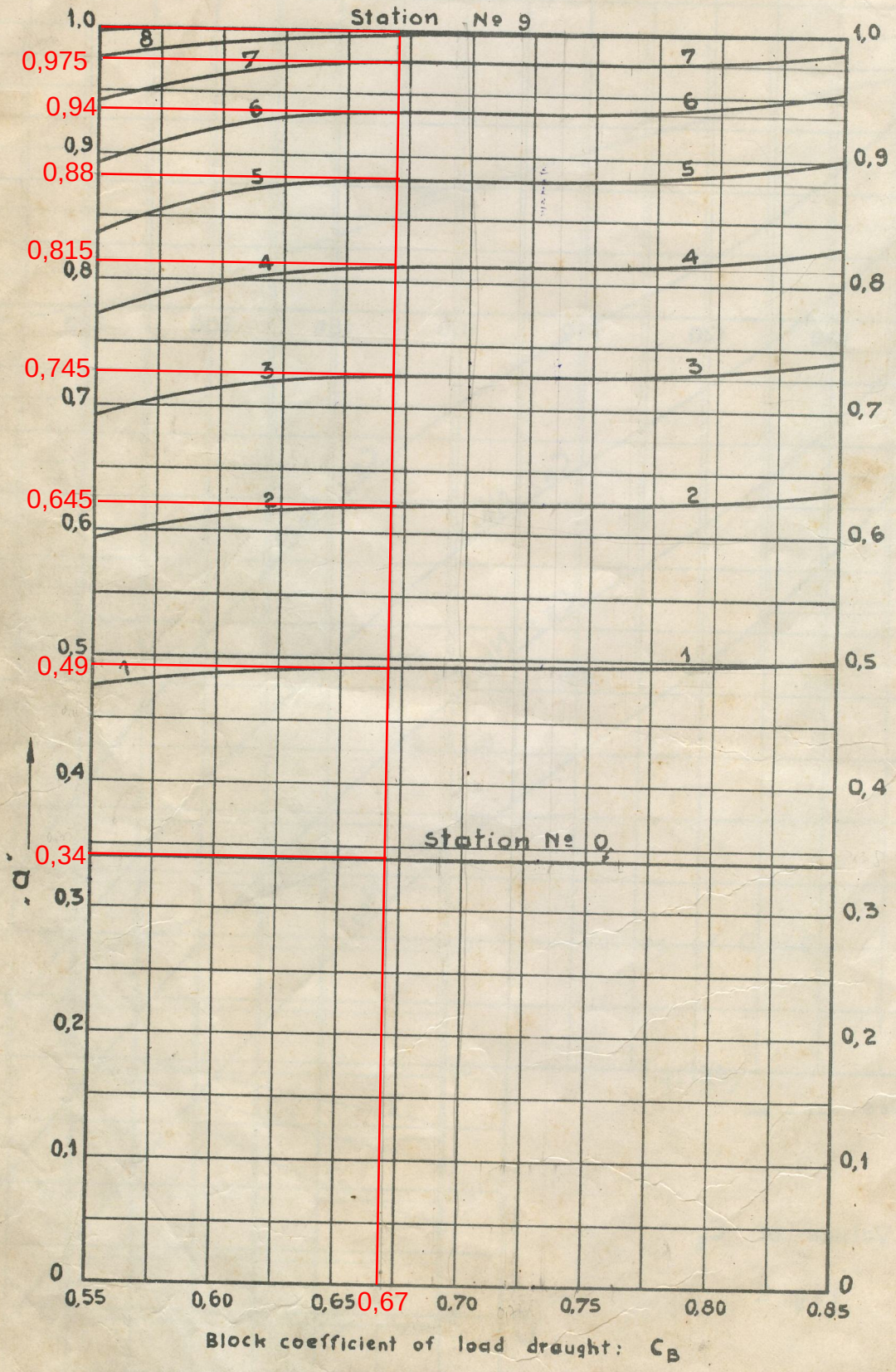


Fig. 3

Values of „a" for Fore Body

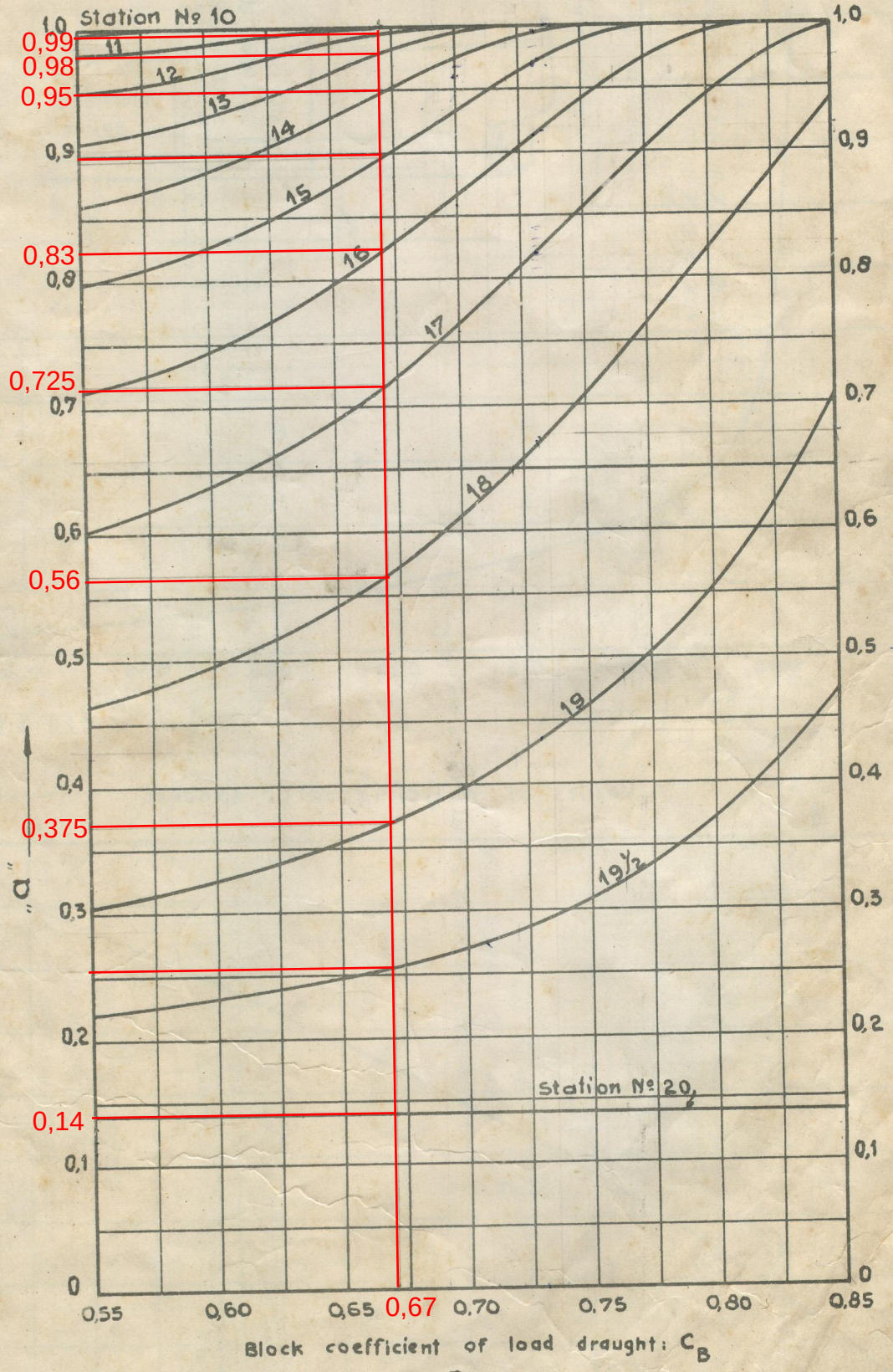


Fig. 4

Values of S

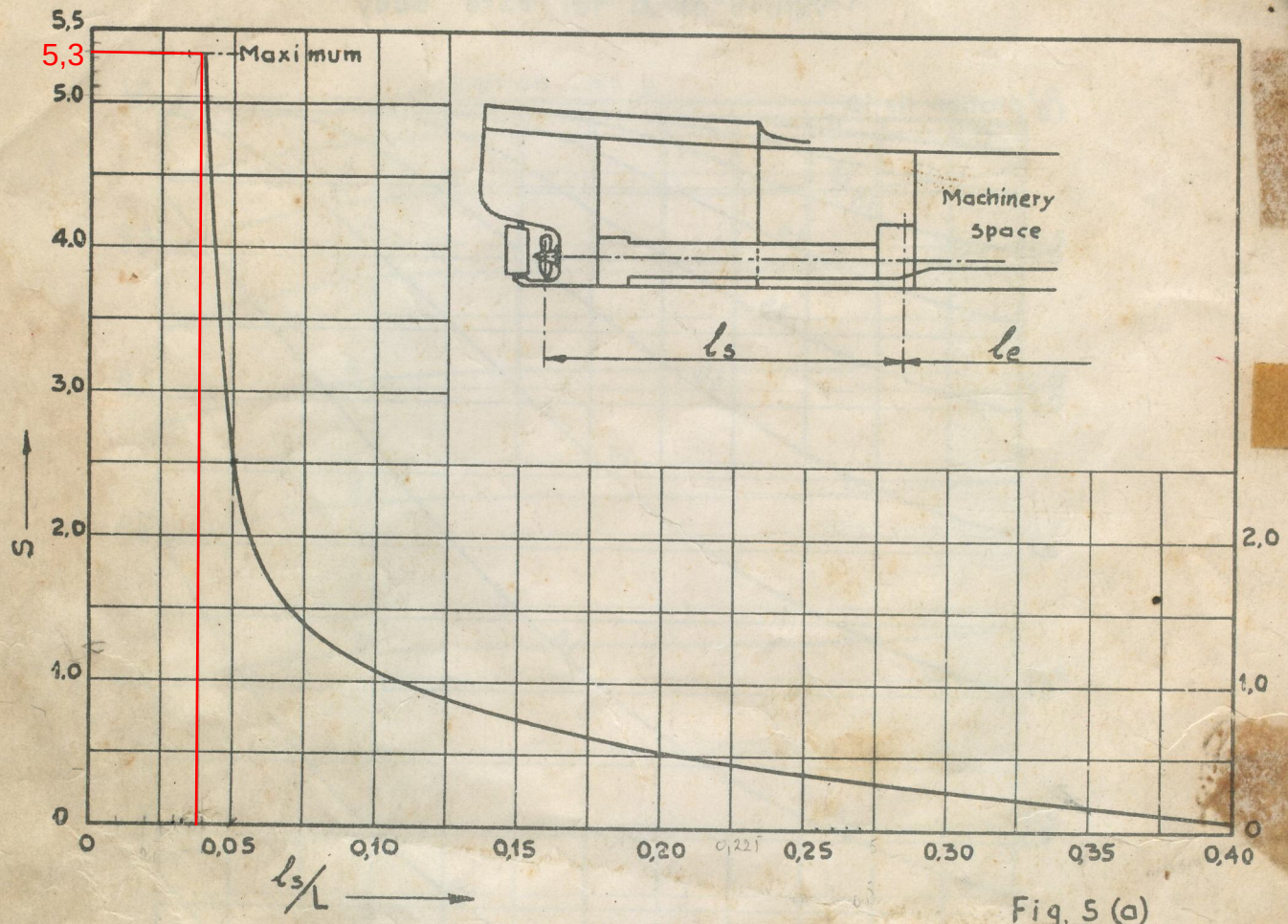


Fig. 5 (a)

Values of W (refrigerated spaces)

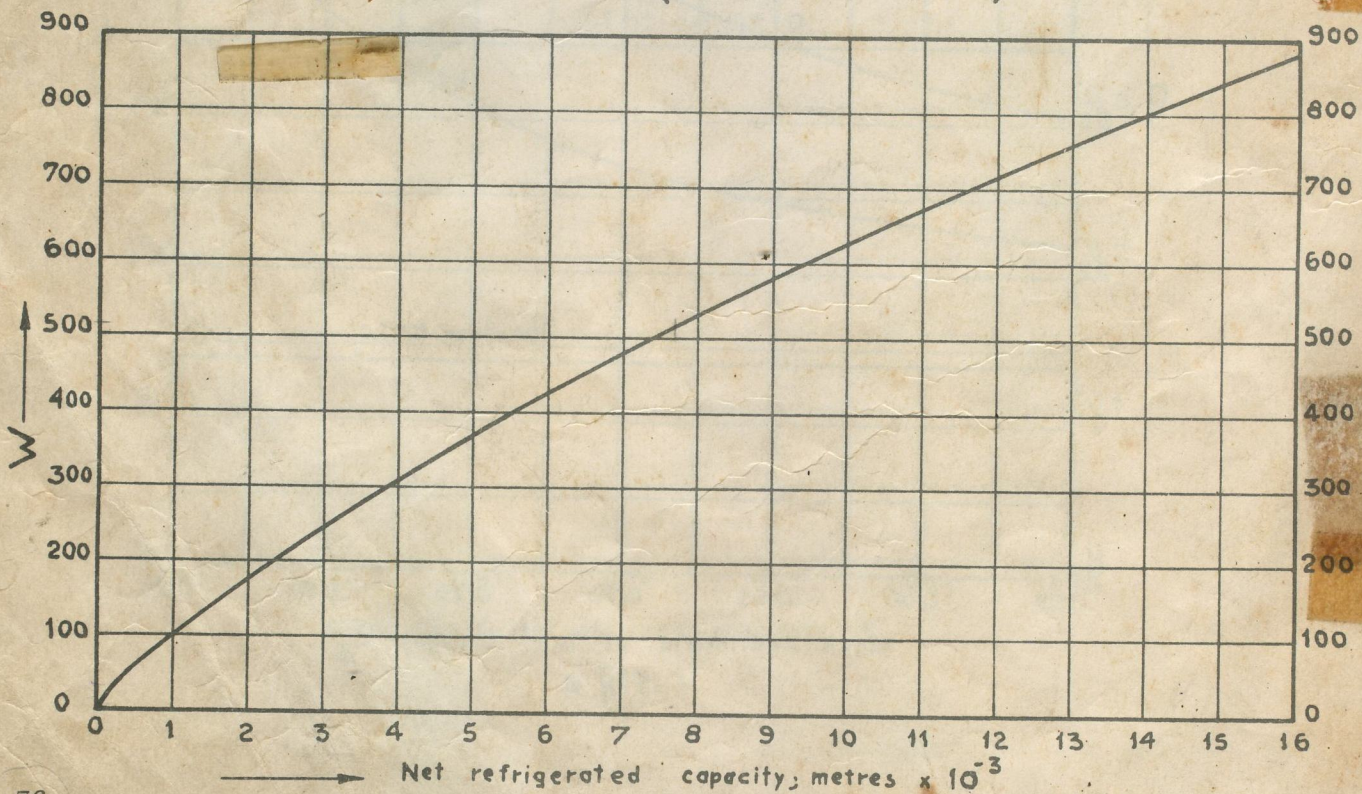
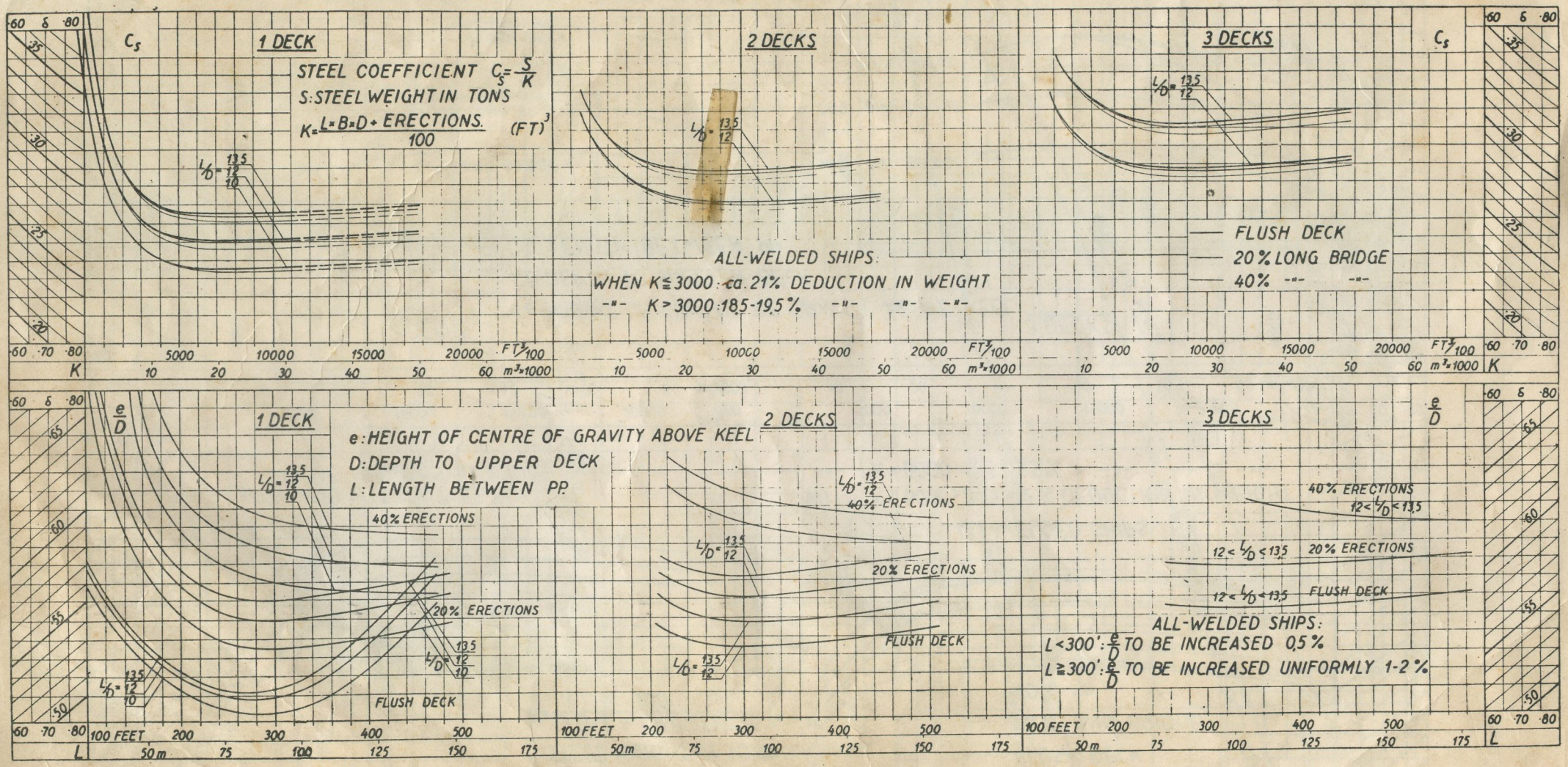


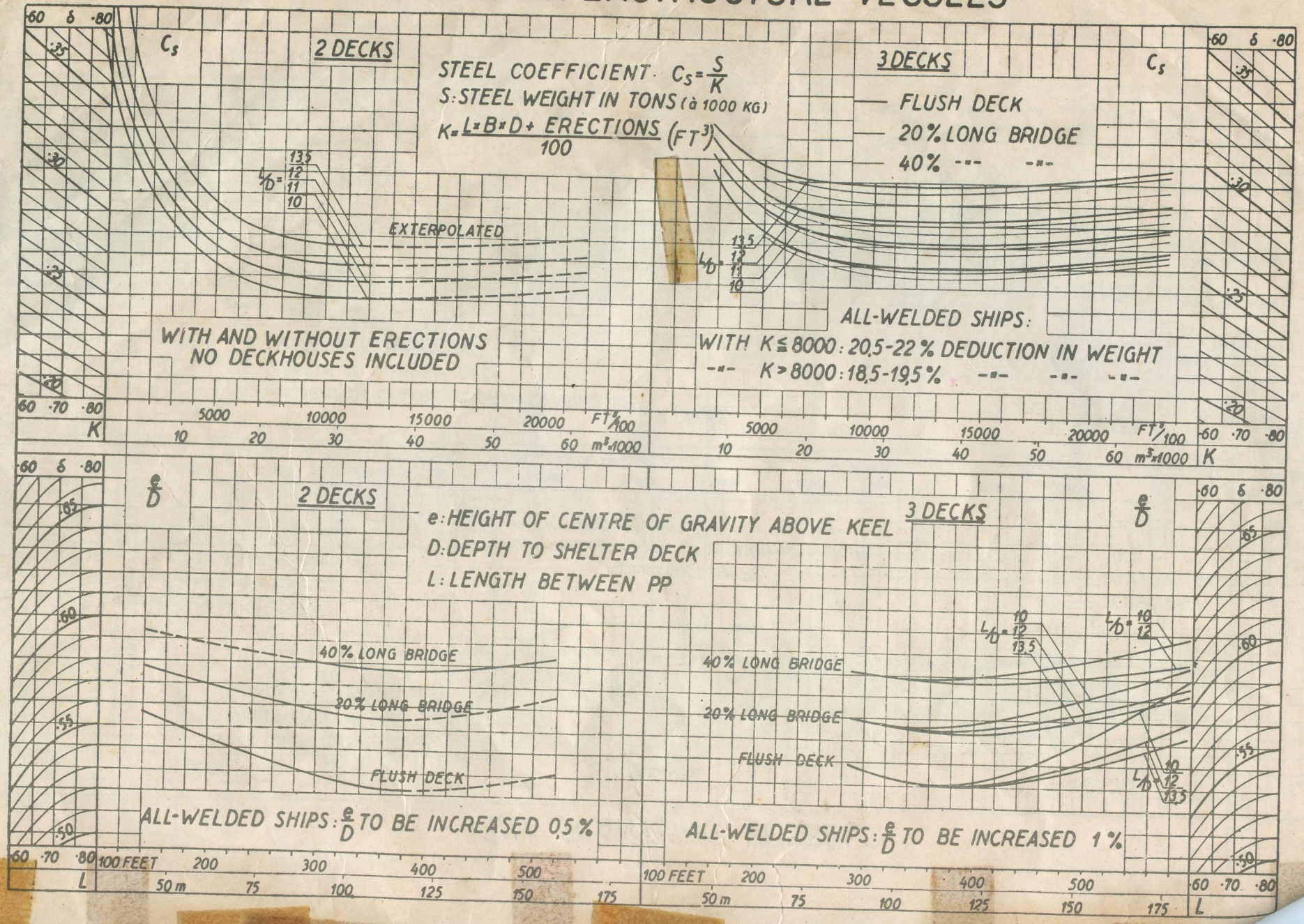
Fig. 5 (b)

FULL SCANTLING VESSELS



ONTWERPEN
43b

COMPLETE SUPERSTRUCTURE VESSELS



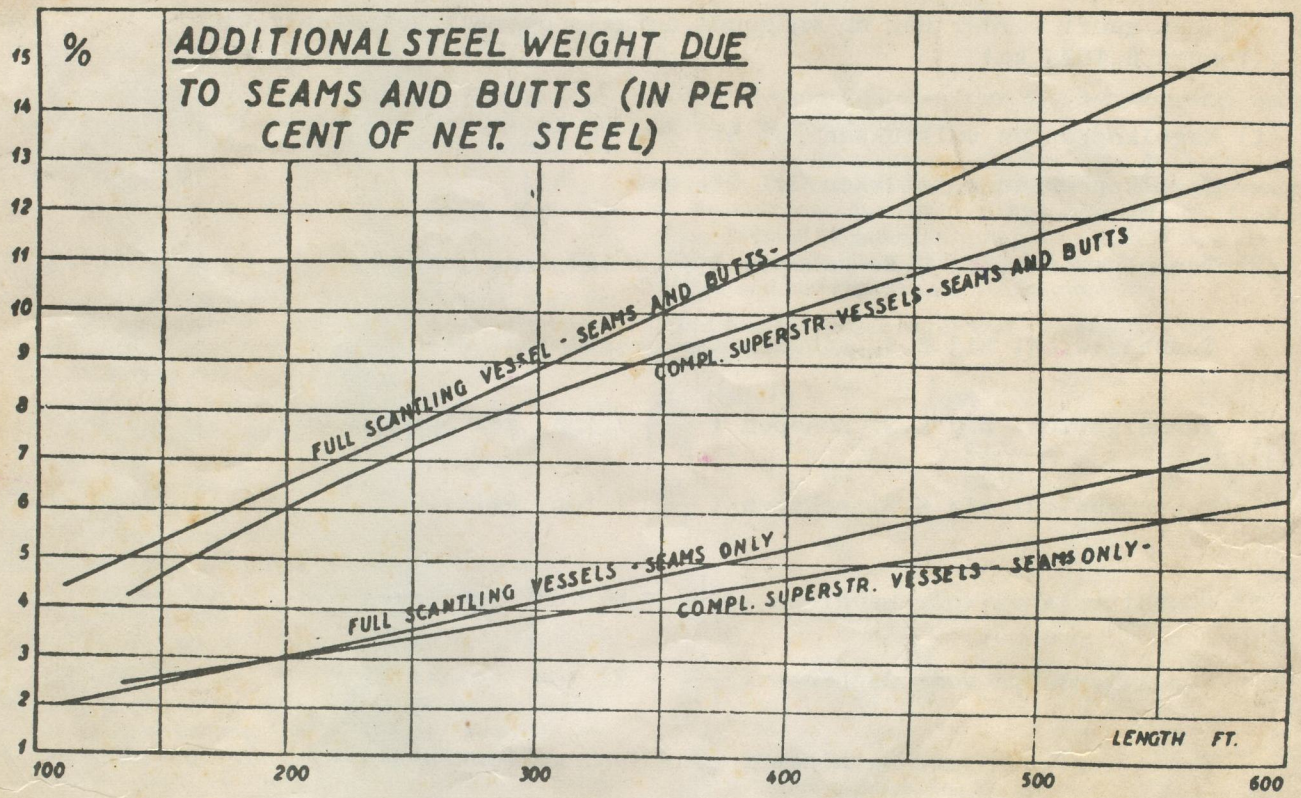

%
ADDITIONAL STEEL WEIGHT DUE TO SEAMS AND BUTTS (IN PER CENT OF NET. STEEL)
FULL SCANTLING VESSEL - SEAMS AND BUTTS
COMPL. SUPERSTR. VESSELS - SEAMS AND BUTTS
FULL SCANTLING VESSELS - SEAMS ONLY
COMPL. SUPERSTR. VESSELS - SEAMS ONLY
LENGTH FT.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
100
200
300
400
500
600

Fig. 1

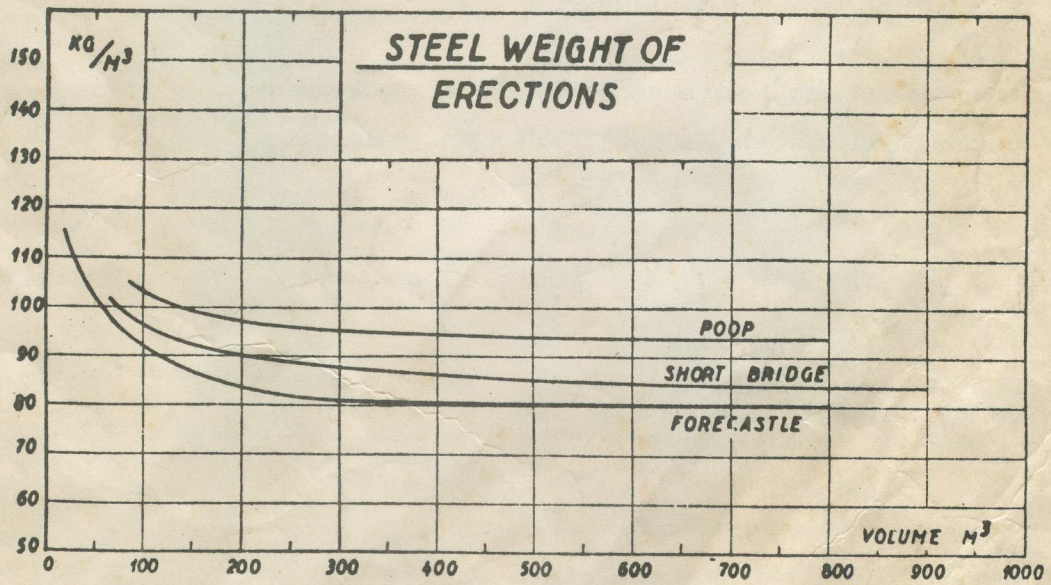

KG/M³
STEEL WEIGHT OF ERECTIONS
POOP
SHORT BRIDGE
FORECASTLE
VOLUME M³
50
60
70
80
90
100
110
120
130
140
150
0
100
200
300
400
500
600
700
800
900
1000

Fig. 2

Raben geeft verder nog de volgende details omtrent het staalgewicht:
(Tonnen à 1000 kg)

(L, B en H in voeten)

1) Nagelkoppen en vulstukken 3% St. gew bij $L < 300'$

Nagelkoppen en vulstukken $3\frac{1}{2}$% St. gew bij $L > 300'$

2) Tunnelgewicht bij E.S. schepen ($\frac{L}{10} - 12$) ton, geklonken $L > 150'$

Tunnelgewicht bij E.S. schepen ($\frac{L}{12} - 10$) ton, gelast $L > 150'$

Tunnelgewicht bij E.S. schepen ($\frac{2L}{100}$) ton, geklonken $L < 150'$

Tunnelgewicht bij E.S. schepen ($\frac{2L}{120}$) ton, gelast $L < 150'$

3) Fundatieplaten voor machines ($\frac{L}{12\frac{1}{2}} - 8$) ton, geklonken bij $L > 150'$

Fundatieplaten voor machines ($\frac{L}{14\frac{1}{2}} - 7$) ton, gelast bij $L > 150'$

Fundatieplaten voor machines ($\frac{2L}{75}$) ton, geklonken bij $L < 150'$

Fundatieplaten voor machines ($\frac{2L}{90}$) ton, gelast bij $L < 150'$

4) Gewichten der dwarsschotten $\frac{L \times B \times H^2}{14 \times 10^4}$ ton, geklonken

Gewichten der dwarsschotten ($\frac{L \times B \times H^2}{15 \times 10^4} + 1$) ton, gelast.

5) Verschansingen van 1,07 m hoog: 164 kg/m, geklonken

Verschansingen van 1,07 m hoog: 138 kg/m, gelast.