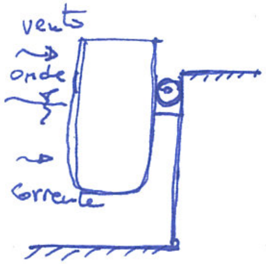
# 3.2 Design Loads (VENTO, CORRENTI, ONDE)

## 3.2.1 *General*

The design load for a limit state is defined as the most unfavourable combination of the characteristic load multiplied by a load coefficient. The limits states are categorized as follows:




- The ultimate limit state (ULS) is related to the risk of failure or large inelastic displacements or strains of a failure character.
- The servicability limit state (SLS) is related to criteria governing normal use or durability.
- The fatigue limit state (FLS) is related to the risk of failure due to the effect of repeated loading.
- The limit state of progressive collapse (PLS) is related to the risk of failure of the structure under the assumption that certain parts of the structure have ceased to perform their load-carrying functions.

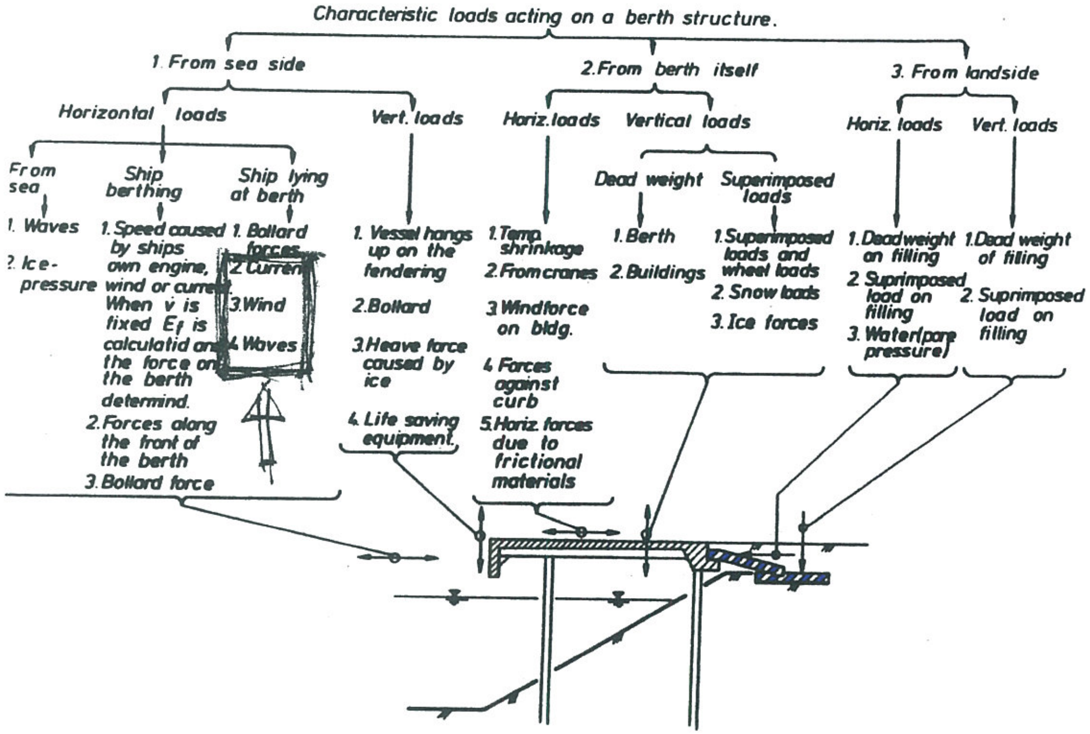



*Fig. 3.2.1.A Characteristic loads acting on a berth structure*



Conditions, described as limit states, are defined states which could occur during the design life of the structure so that it would fail to fulfil satisfactorily its intended functions or that it would become unfit to do so. Sets of factors are then specified so that the probability of each limit state occuring during the design life of the structure does not exeed a value agreed to be acceptable having regard to the consequences of the limit state occuring.

The characteristic load is defined as the load which has a known probability p, based on annual extremes, that it will not be exceeded in an individual year. The characteristic load may be a permanent load, variable load of a return period of 50 years, fatigue load and accidental load. According to the acceleration which the load gives to the structure it is also divided into static load and dynamic load. The load coefficient does not include the dynamic allowances.

The objectives of the characteristic load criteria given in this main chapter are to ensure that structures and structural elements among other things are designed to:

- sustain all loads and deformations with an acceptable degree of safety against failure
- perform adequately in normal use with respect to deterioration, displacements, etc.
- have adequate fatigue resistance

In the different limit states, there are three main categories of characteristic loads or forces acting on a berth structure:

1. characteristic loads from the sea side
2. characteristic loads on the berth structure
3. characteristic loads from the land side

Figure 3.2.1.A shows in some detail the various types of forces which usually occur. In this chapter the characteristic loads under categories 1 and 2 will be discussed in more detail.

## 3.2.2 *Characteristic Loads From the Sea Side*

### 3.2.2.1 Wave Action

Since most berth structures are sheltered against sizable waves, the statical calculations of berth structures normally do not explicitly deal with forces and reactions due to wave action. Such forces are assumed to be taken care of by the very fact that the structure is also designed for impact and mooring forces. For breakwaters and similar structures heavily exposed to waves the wave actions must of course be studied very closely in each case.

# AZIONI SULLE NAVI ALL'ORMEGGIO da parte di

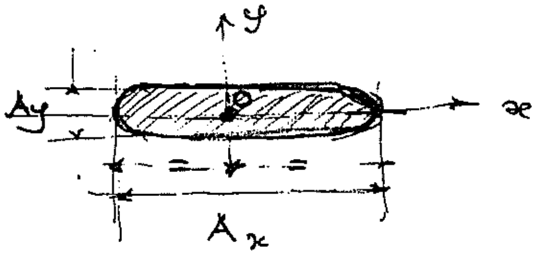
- correnti e vento
- onde

~~1~~ (2)

## Correnti e vento

Le prime agiscono sulla parte immersa dello scafo e sono ovviamente massime in condizioni di massima immersione (pieno carico) della nave; le seconde, agendo sulla parte emersa dello scafo e sulle sovrastrutture, sono massime per le condizioni di zavorra (ballast) o addirittura per nave completamente scarica (se nave ormeggiata in disarmo)

Le relazioni generali sono




$$F_x = \frac{1}{2} \rho v^2 A_y C_x$$

$$F_y = \frac{1}{2} \rho v^2 A_x C_y$$

Poiché la forza risultante non sarà ovviamente passante per l'origine degli assi O (scelta a ½ lunghezza), sarà necessario fornire il punto di applicazione attraverso le sue coordinate o attraverso un momento (asse verticale) rispetto a O.

Si osserva che i coefficienti idro o aerodinamici $C_x$ $C_y$ devono dipendere dalla direzione vento o corrente, dalla forma dello scafo e, per le correnti, dal rapporto tra la profondità del mare e il pescaggio dello scafo.

The mean wind velocity and direction should be recorded 10 m above mean sea level and should be based upon the 10-minute averages of the wind velocity and direction.

Provided that no specified information of the gust ratio is available, i.e. the ratio between the short-period wind speed to the mean wind speed for the wind conditions at the site, PIANC recommend that the following table could tentatively be applied for larger wind velocities (6). The table shows the relationship between the 1-hour mean wind speed and the associated maximum speeds for a range of shorter mean durations:

| Wind duration | Gust factor |
|---|---|
| 3-sec. mean | 1.56 |
| 10-sec.mean | 1.48 |
| 1-min. mean | 1.28 |
| 10-min. mean | 1.12 |
| 30-min. mean | 1.05 |
| 1-hour mean | 1.00 |

← fattore di raffica

Il tempo della raffica da tenere in conto dipende molto dalle dimensioni della nave

The Norwegian Petroleum Directorate (7) recommends that the maximum wind speed averaged over short time periods may be obtained by multiplying the actual 10 minute mean wind speed by the following gust factors:

| Wind duration | Gust factor |
|---|---|
| 3 sec mean | 1.35 |
| 10 sec mean | 1.30 |
| 15 sec mean | 1.27 |
| 30 sec mean | 1.21 |
| 1 min mean | 1.15 |
| 10 min mean | 1.00 |

For port and ship operation it is claimed in accordance with (6) that gust duration shorter than about 1 minute will be of secondary importance, but at some oil terminals around the North Sea it has been observed that wind duration down to 20-30 sec. may affect tankers in ballasted condition. The design wind speed for a moored ship is according to (11) the mean wind speed corresponding to the shortest gust which will affect the ship at any time, having a return period of 50 years and taking account of the height of the ship and the wind speed/height gradient. In the case of moored ship, the gust duration must also be sufficient for the mooring line or fender strains to develop, taking account of the inertia of the ship.

As a very rough guideline for operation of an oil and gas berth, the following wind velocities are suggested as limits for oil and gas tankers during the following operations:

Più grosse sono le navi, più lungo sarà il periodo di raffica da considerare

- Approximately 10 m/s or 20 knots during berthing of tankers with a laterally projected wind area of more than about 5000 m² (i.e. oil tanker more than about 150000 dwt or LNG tanker more than about 80000 m³ in ballast loaded condition), and approximately 15 m/sec or 30 knots during berthing of tanker with a laterally projected wind area of less than about 3000 m² (i.e. oil tanker less than 70000 dwt or LPG tanker less than 50000 m³ or LNG tanker less than 30000 m³ in ballast loaded condition).
- Approximately 20 m/s or 40 knots during loading and unloading operation, and the loading arms should be disconnected at 23 m/s or 45 knots.
- Maximum 26 m/s or 50 knots at berth, but ballasted to reduce the wind area of the ship and with emergency mooring wires. In this case at least one tugboat should be on standby to assist any tanker alongside the berth if required.
- More than 26 m/s wind velocity, the tanker will, if possible, normally leave the berth.

At some large new oil and gas terminas due to environmental safety in e.g. Japan, the acceptable wind limit during berthing is 10 m/s for all tanker sizes. The operational limit for the loading arms during loading and unloading is 15 m/s, and the loading arms are disconnected at a wind speed of 20 m/s.

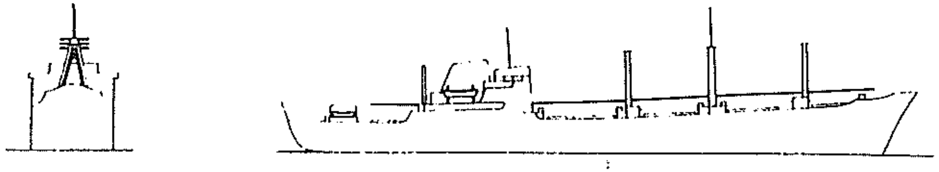
The given values are based on 10 minute average wind velocities (the Beaufort wind scale). The figures will also depend upon the wave and current situation at the berth.

For modern mooring boats or launches, a wind speed of about 12-15 m/s or a significant wave height of 1.0 – 1.3 m must be taken as guideline limits for safe operation. If these limits are exceeded, the mooring boats will experience difficulty in delivering the mooring lines from the ship to the mooring points at the berth.

It shall also be remembered and recognized that due to wind generated waves, tugboats will have operational limits. With significant wave heights of more than 1,0 – 1,5 metres for ordinary tugboats and 1,5 metres for tractor tugboat, tugboats start to lose efficiency in controlling ships.

The design wind load for the berth structures itself, dolphins and mooring equipment must be based on wind velocities in accordance with recommended standards, acting on the moored tanker. This is due to the fact that if the

VENTO



CARGO SHIP A (BALLAST)

$C_x, C_Y, M_y, M_R$

| | |
|---|---|
| Length between perpendiculars: | 127.5 m |
| Length overall ($L_{oa}$): | 141.1 m |
| Breadth: | 18.5 m |
| Projected front area ($A_f$): | 359.5 m$^2$ |
| Projected side area ($A_s$): | 1559.2 m$^2$ |
| Centre of $A_s$ over water ($H_s$): | 6.8 m |

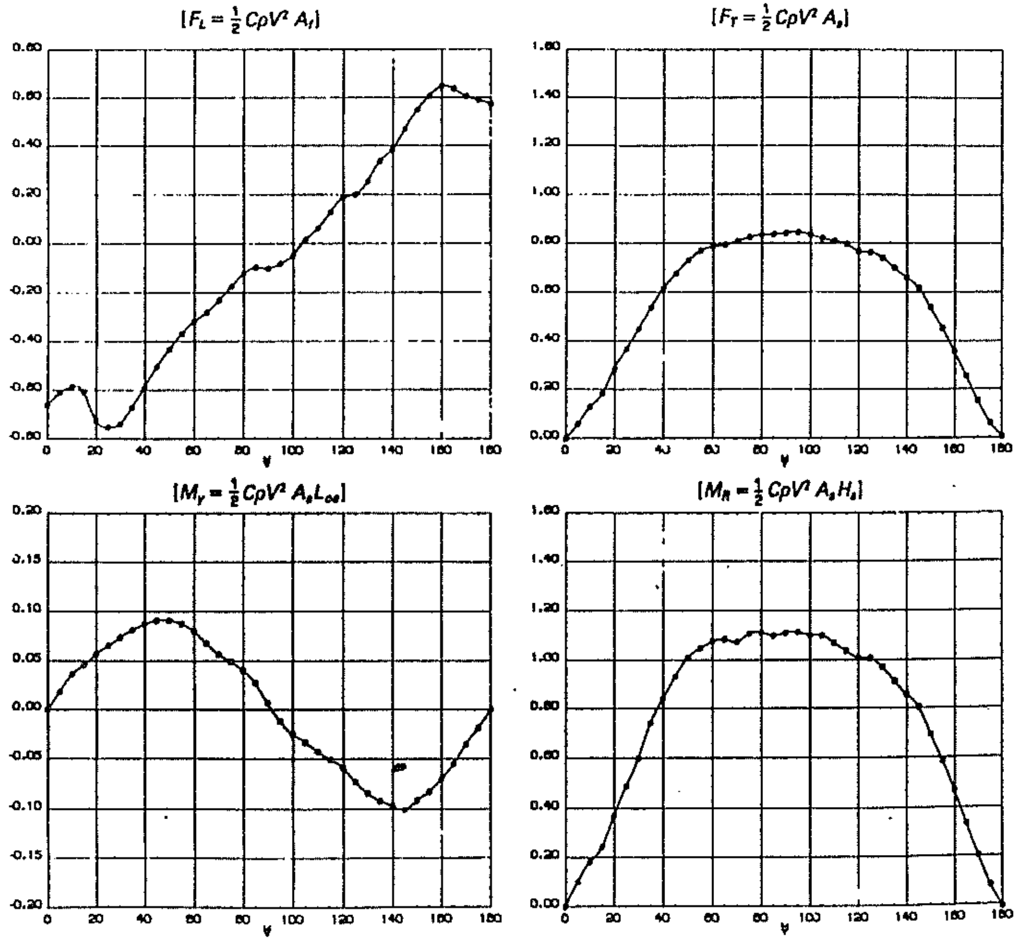
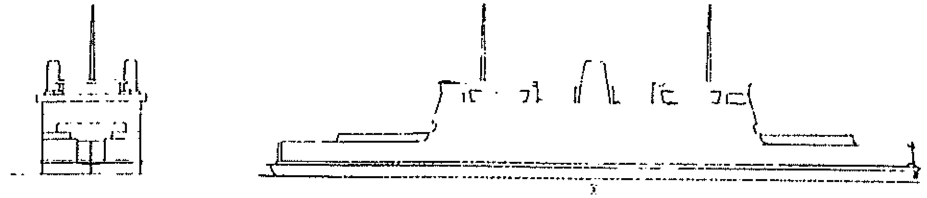



Fig. 3.4 (a) Wind Force Coefficients for General Cargo Ship in Ballast. Reproduced by permission of the Danish Ship Research Laboratory



FERRY

| | |
|---|---|
| Length between perpendiculars: | 83.0 m |
| Length overall ($L_{oa}$): | 84.7 m |
| Breadth: | 13.4 m |
| Projected front area ($A_f$): | 155.6 m$^2$ |
| Projected side area ($A_s$): | 704.5 m$^2$ |
| Centre of $A_s$ over water ($H_s$): | 4.9 m |

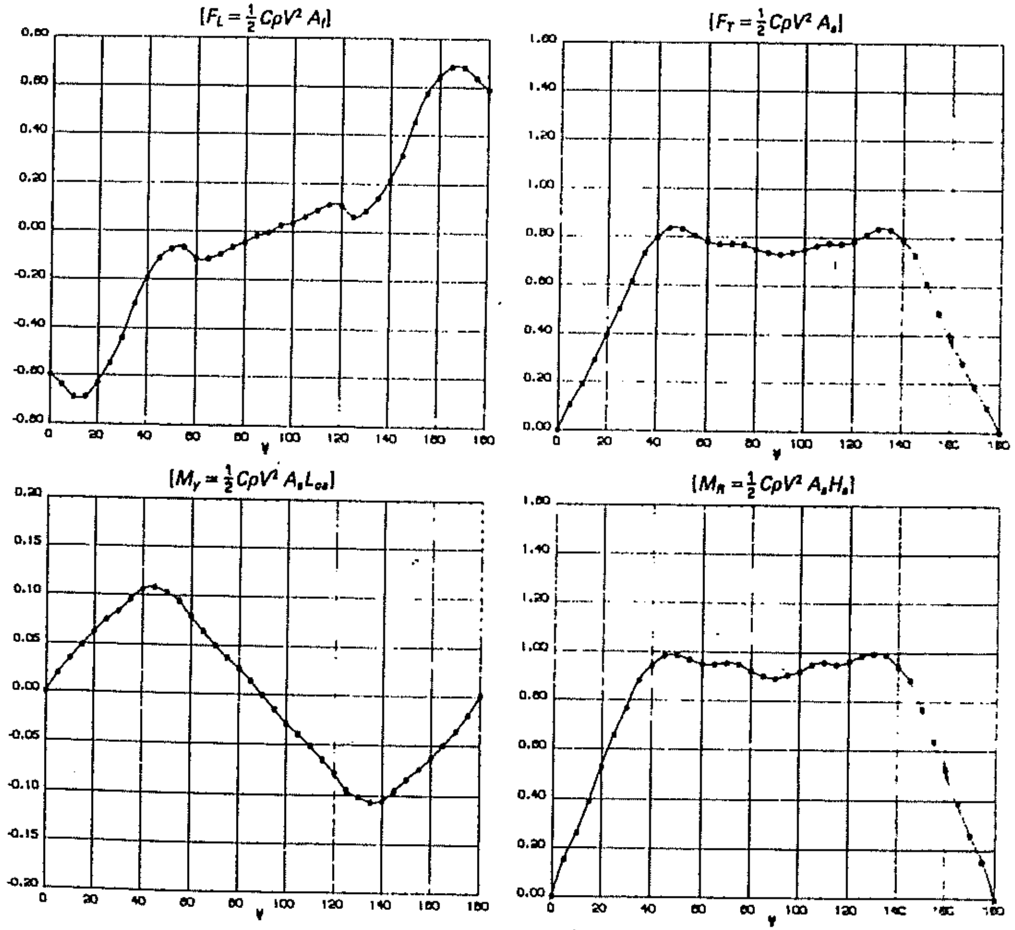



Fig. 3.4 (d) Wind Force Coefficients for Ferry. Reproduced by permission of the Danish Ship Research Laboratory

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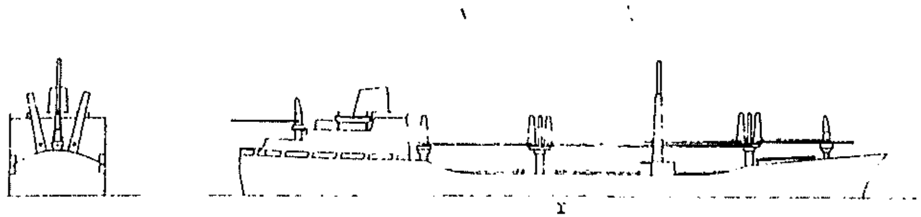
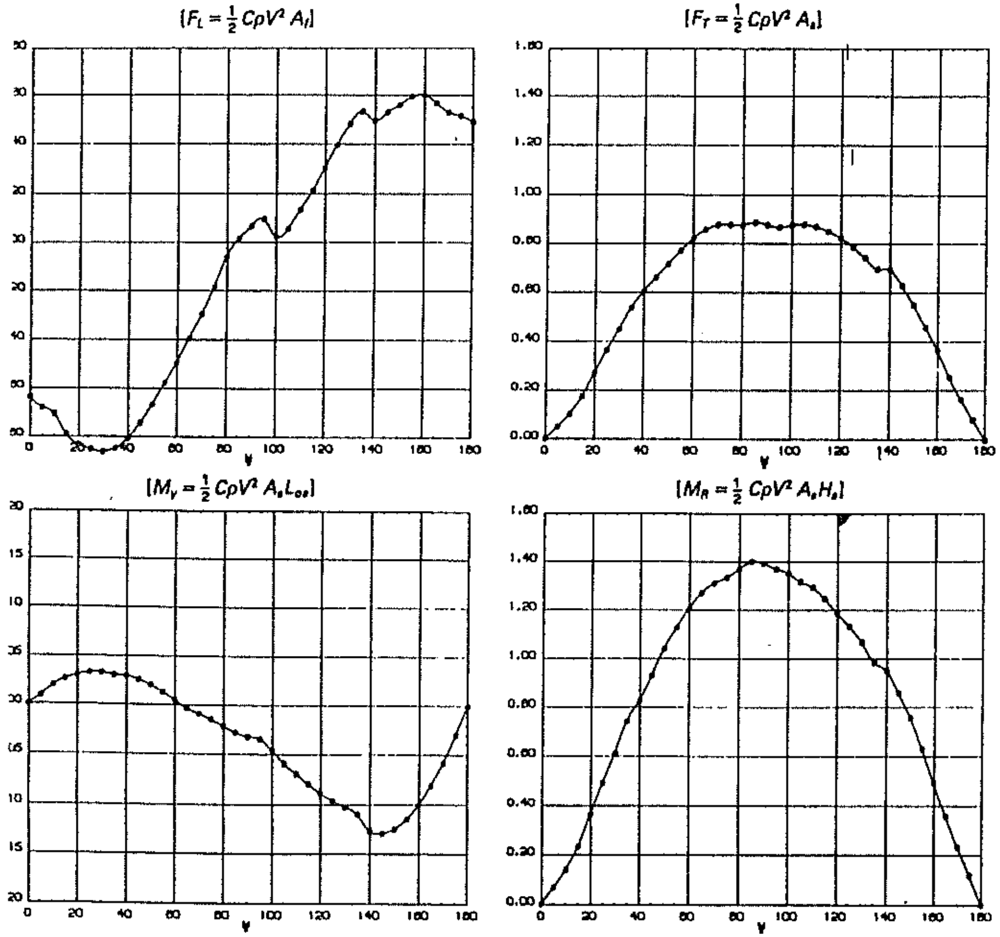


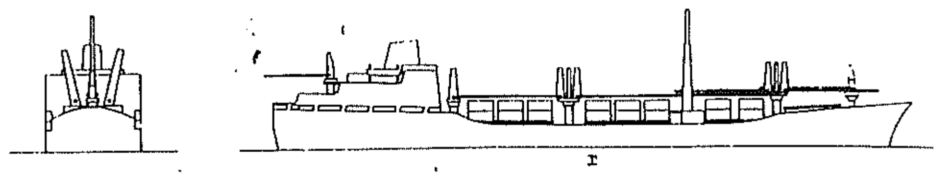
CARGO SHIP B (FULLY LOADED BUT WITHOUT CONTAINERS)

VENTO

| | |
|---|---|
| Length between perpendiculars: | 144.8 m |
| Length overall ($L_{oa}$): | 155.5 m |
| Breadth: | 23.2 m |
| Projected front area ($A_f$): | 488.0 $m^2$ |
| Projected side area ($A_s$): | 1734.8 $m^2$ |
| Centre of $A_s$ over water ($H_s$): | 7.7 m |




g. 3.4 (b) Wind Force Coefficients for General Cargo Ship. Fully Loaded but without ontainers on Deck. Reproduced by permission of the Danish Ship Research Laboratory



CARGO SHIP B (FULLY LOADED AND WITH CONTAINERS)

| | |
|---|---|
| Length between perpendiculars: | 144.8 m |
| Length overall ($L_{oa}$): | 155.5 m |
| Breadth: | 23.2 m |
| Projected front area ($A_f$): | 488.0 $m^2$ |
| Projected side area ($A_s$): | 1971.4 $m^2$ |
| Centre of $A_s$ over water ($H_s$): | 7.7 m |

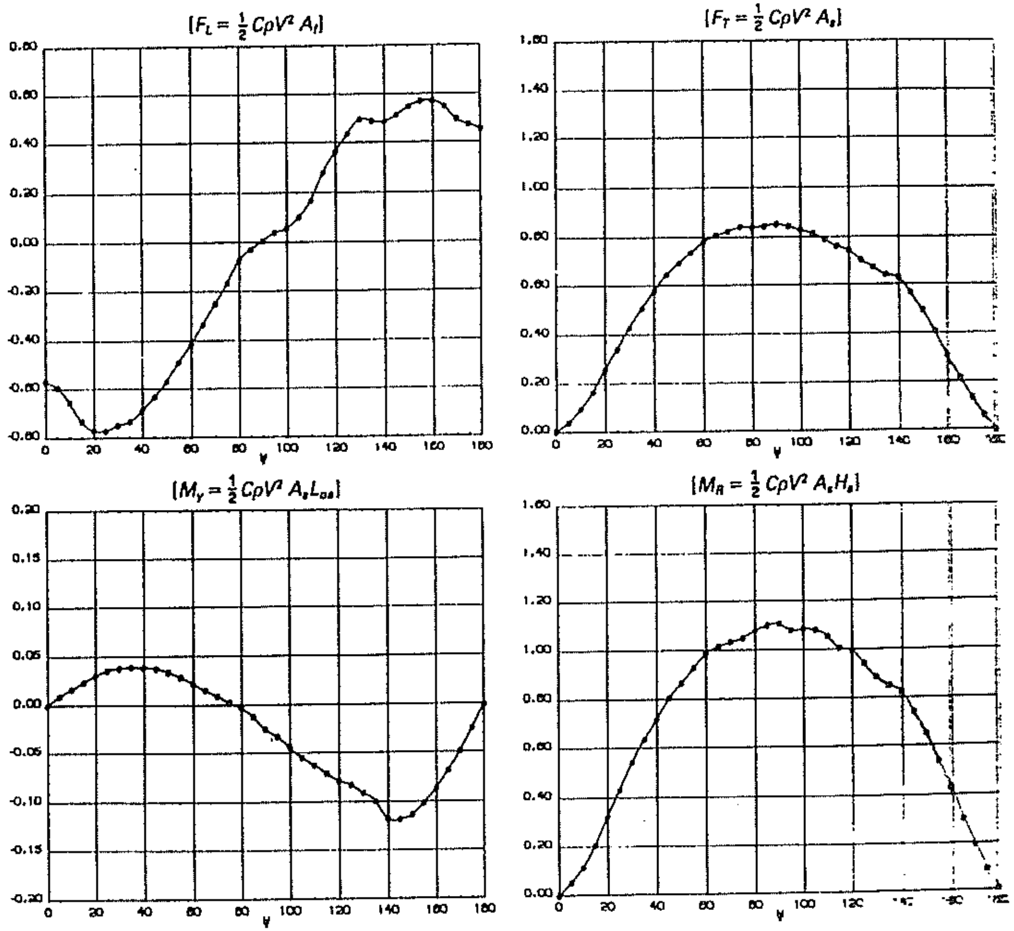



Fig. 3.4 (c) Wind Force Coefficients for General Cargo Ship. Fully Loaded with Containers on Deck. Reproduced by permission of the Danish Ship Research Laboratory

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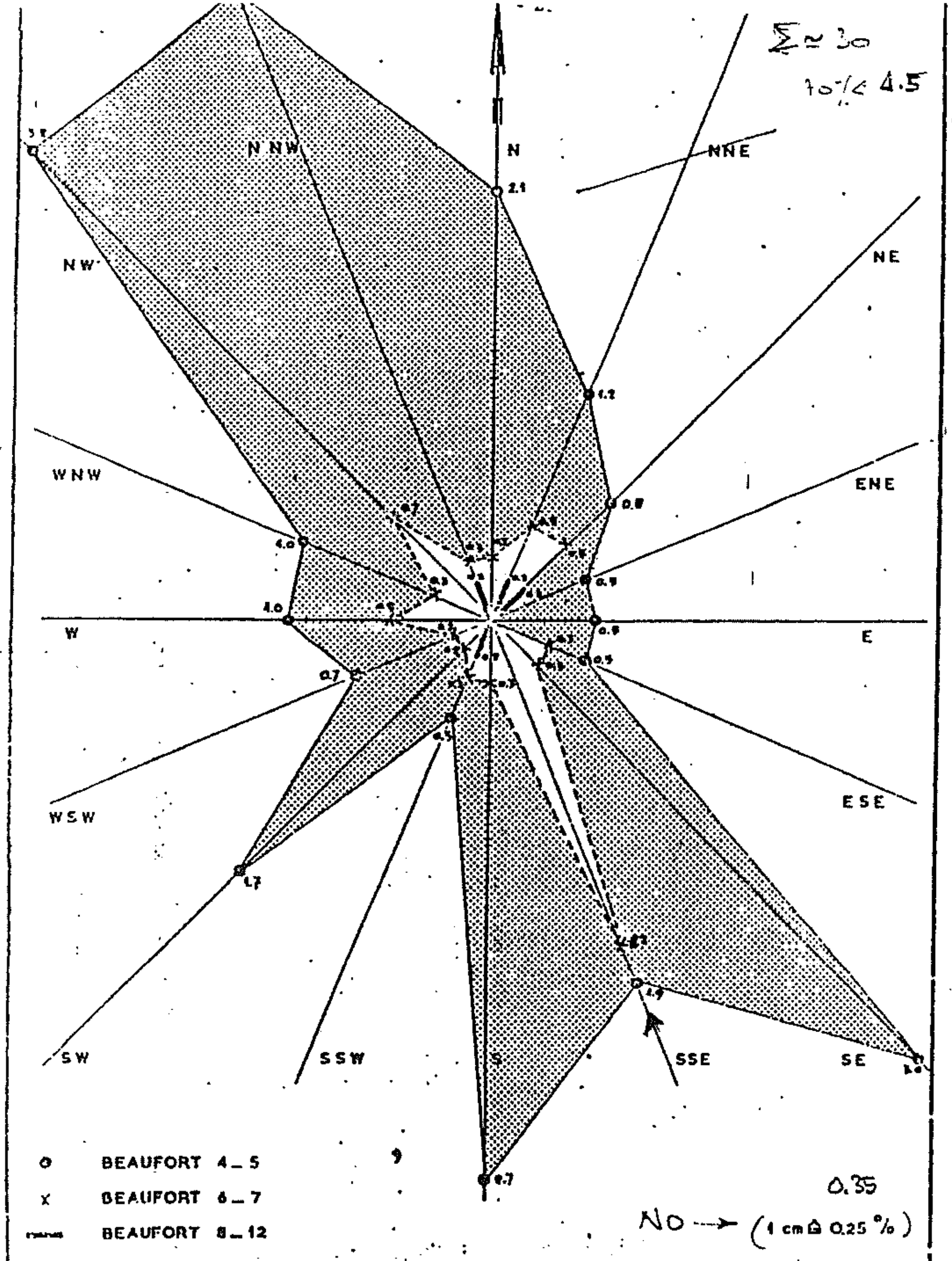



o BEAUFORT 4 – 5
x BEAUFORT 6 – 7
—— BEAUFORT 8 – 12

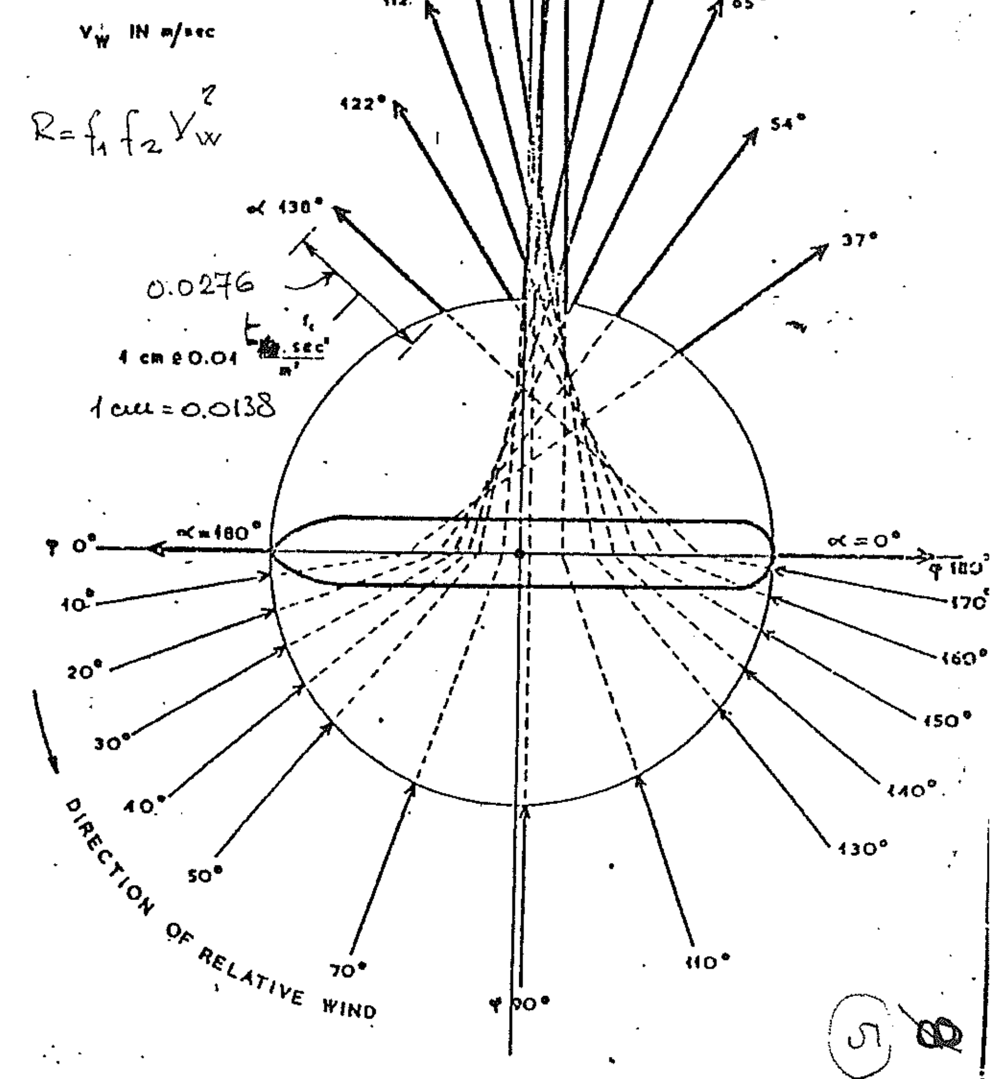
ANNUAL PERCENTAGES OF WIND DIRECTION AND STRENGTH FOR THE MANFREDONIA AREA ACCORDING TO [6]

WATERLOOPKUNDIG LABORATORIUM | R. 570 | Fig. 15

$R = f_1 \cdot f_2 \cdot V_W^2$

| D.W.T. | $f_2$ |
|---|---|
| 15,000 | 0.87 |
| 25,000 | 1.00 |
| 35,000 | 1.13 |

$V_W$ IN m/sec




RESULTANT FORCE VECTORS IN RELATION TO THE WIND DIRECTION (BALLAST CONDITION; BRIDGE AMIDSHIPS)

WATERLOOPKUNDIG LABORATORIUM | R. 570 | Fig. 16

# Costa Fortuna

*Da Wikipedia, l'enciclopedia libera.*

La ***Costa Fortuna*** è una nave da crociera della compagnia genovese Costa Crociere costruita presso i Cantieri navali di Sestri Ponente a Genova. La nave è stata seguita un anno più tardi dalla gemella Costa Magica

È stata tenuta a battesimo il 6 novembre del 2003 da Maria Grazia Cucinotta e durante il suo viaggio inaugurale ha ospitato a bordo il soprano Katia Ricciarelli

L'arredamento progettato dall'architetto statunitense Joe Farcus si ispira ai grandi transatlantici italiani del passato a cui viene posposto il loro anno di varo. Così ad esempio troveremmo su questa nave il teatro denominato Rex 1932 oppure il bar Conte di Savoia 1932. I modelli di queste navi sono in mostra negli spazi pubblici mentre nell'atrio ci sono i modelli di 26 navi del passato che hanno fatto parte della flotta della Costa.
Le aree pubbliche sono decorate con riproduzioni di immagini pubblicitarie degli anni venti e con manifesti pubblicitari dei transatlantici Michelangelo e Raffaello. La costa fortuna si è insabbiata dinanzi al porto di Savona senza gravi conseguenze. In poco tempo i rimorchiatori sono riusciti a portarla verso la banchina del Palacrociere. Nessun danno tranne delle strisce lungo le fiancate.

*Costa Fortuna*

| | |
|---|---|
| **Descrizione generale** | |
| **Tipo** | Nave da crociera |
| **Costruttori** | Fincantieri |
| **Cantiere** | Sestri Ponente (GE), Italia |
| **Varo** | 11 luglio 2002 |
| **Entrata in servizio** | 2003 |
| **Proprietario** | Costa Crociere S.p.A. |
| **Caratteristiche generali** | |
| **Stazza lorda** | 102.587 t |
| **Lunghezza** | 272,20 m |
| **Larghezza** | 36 m |
| **Altezza** | 66 m |
| **Pescaggio** | 8,20 m |
| **Propulsione** | sei motori Sulzer diesel 63.360 Kw |
| **Velocità** | 20 nodi |
| **Equipaggio** | 1.027 |
| **Passeggeri** | 3.470 |
| Note | |
| **Porto di registrazione** | Genova |

## Navi gemelle

- Costa Magica

# Costa Magica

*Da Wikipedia, l'enciclopedia libera.*

La ***Costa Magica*** è una nave da crociera della compagnia genovese Costa Crociere.

Nave gemella della Costa Fortuna è stata varata nel 2004 dalla Fincantieri nei cantieri navali di Sestri Ponente.

Il filo conduttore dell'arredamento è la *magia* dell'Italia che si manifesta con le immagini di alcuni tra i luoghi più belli come la Costa Smeralda, Ostia Antica, Positano, Portofino, Palinuro, la Sicilia, Isola Bella, Spoleto, Capri, Grado, Vicenza e Bressanone.

| *Costa Magica* | |
|---|---|
| **Descrizione generale** | |
| **Tipo** | Nave da crociera |
| **Costruttori** | Fincantieri |
| **Cantiere** | Sestri Ponente (GE), Italia |
| **Varo** | 14 novembre 2003 |
| **Entrata in servizio** | 2004 |
| **Proprietario** | Costa Crociere S.p.A. |
| **Caratteristiche generali** | |
| **Stazza lorda** | 102.587 t |
| **Lunghezza** | 272 m |
| **Larghezza** | 38 m |
| **Altezza** | 60(dalla linea di galleggiamento) m |
| **Pescaggio** | 8,20 m |
| **Propulsione** | sei motori Sulzer diesel 63.360 Kw |
| **Velocità** | 20 nodi |
| **Passeggeri** | 3.470 |
| **Note** | |
| **Porto di registrazione** | Genova |

## Navi gemelle

- Costa Fortuna

## Collegamenti esterni

- Foto nave (http://www.faktaomfartyg.se/costa_magica_2004_b_7.htm)
- Costa Crociere (http://www.costacrociere.it/)

**Portale Trasporti**: accedi alle voci di Wikipedia che parlano di trasporti

Categorie: Stub navi | Navi da crociera

- Ultima modifica per la pagina: 00:18, 24 ott 2007.

# CORRENTI

Nel foglio a parte sono fornite le relazioni nella elaborazione proposta dal NETHERLANDS SHIP MODEL BASIN DI WAGENINGEN che riporta $C_x$ e $C_y$ in un unico coefficiente $C_{yc}$ estraendo da esso la dipendenza da $\alpha_c$ ed inserendola nella formula e riferendo i valori di $A_x$ e $A_y$ alla sola lunghezza $L_{pp}$ che, per la nave **tanker** studiata, può orientativamente considerarsi pari a 6 volte la larghezza della nave.

Il valore di $C_{yc}$ viene pertanto dato in funzione del solo rapporto $h/d$ (profondità del mare/pescaggio della nave).

L'effetto della corrente sulla rotazione della nave sul piano orizzontale (asse verticale) viene dato attraverso l'eccentricità, e.

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S. ha usato la nuova edizione e ha consegnato anche la pagina dopo

THORESEN 2003

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### 2.1.4 *Current*

The magnitude and direction of the tidal current and the wind generated currents must be evaluated to establish any influence on the berthing and deberthing operations.

Currents can arise in a port basin due to wind transporting water masses, differences in temperature and salt contents, tidal effects, water flow from river estuaries, etc. At some of the Norwegian harbour situated at the mouth of a river, the currents are known to have reached a velocity of 3 m per sec. or 6 knots.

When designing new quays it is always important to ensure that the quay front is directed as parallel as possible to the prevailing current. Since the direction of the current can vary, it is also necessary to investigate over a longer time period the magnitude of the current perpendicular to the direction of the quay front. Should such a component reach a value of about 0.5 m per sec. perpendicularly to an open pier, the berthing operation would be very difficult.

Even if currents do not usually set up loads of vital importance to a finished quay, they can still be of importance during the construction of the quay. For instance, the normal driving of piles is hardly possible if the current velocity is higher than 1.5 m per sec. Divers will hardly be able to work properly if the current velocity is higher than 0.5 m per sec.

Tidal currents must be measured at various depths in the harbour area. The tidal current is referred to as a flood current on a rising tide and an ebb current on a falling tide.

The magnitude of wind generated currents will at open sea be approximately 1% to 2% of the wind speed at 10 m above the water level.

Berthing structure and the mooring equipment for VLCC's, should be capable of resisting loads due to any one of the following current conditions acting simultaneously with the design wind from any of the following directions: 1,5 m/s or 3 knots at 0° and 180° (current parallel to the berth), 1,0 m/s or 2 knots at 10° and 170°, and 0,4 m/s or 0,75 knots from direction of maximum

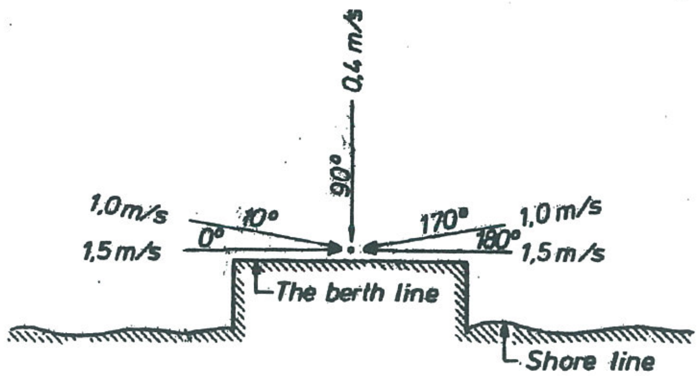



*Fig. 2.1.4.A Current direction and velocity*

beam current loading as shown in figure 2.1.4.A. For the above three conditions the water depth to loaded draft ratio is assumed to be 1,1:1,0.

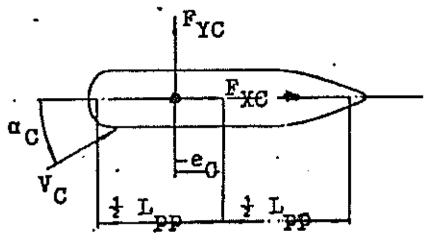
Manca [illegible] dopo

4. Current forces

The current force on the tankers has been calculated from:

$$F_{YC} = \tfrac{1}{2}\,\rho\,V_C^{\,2}\,.\,L_{pp}\,d\,.\,C_{YC}\,\sin^{3/2}\alpha_C$$

$$F_{XC} = \tfrac{1}{2}\,\rho\,V_C^{\,2}\,.\,L_{pp}\,d\,.\,0.03\,C_{YC}\,\cos\alpha_C$$




in which:

$F_{YC}$ = athwart-ships current force
$F_{XC}$ = along-ships current force
$\rho$ = mass density of sea water
$L_{pp}$ = length of ship between perpendiculars
$d$ = draft of ship
$V_C$ = current velocity
$\alpha_C$ = direction of current relative to the ship's heading
$C_{YC}$ = dimensionless current force coefficient

In Figure 4 $C_{YC}$ is given as a function of the water depth - draft ratio $h/d$.

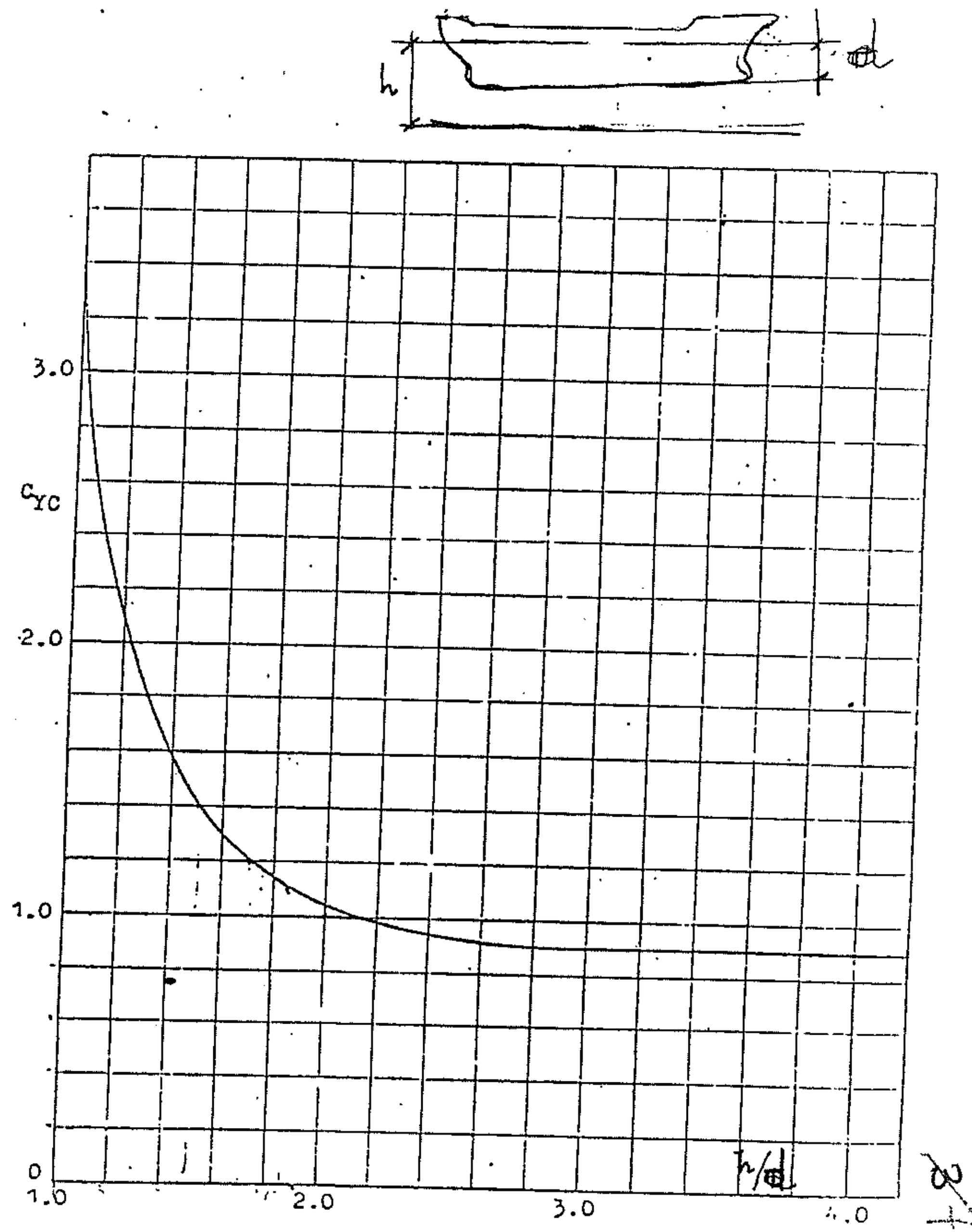
The point of application of the current force can be approximated by:

$$e_C = \left(\frac{\alpha_C - 90}{90}\right)\,.\,0.32\,L_{pp}$$



Non visto

Dimensionless current force coefficient

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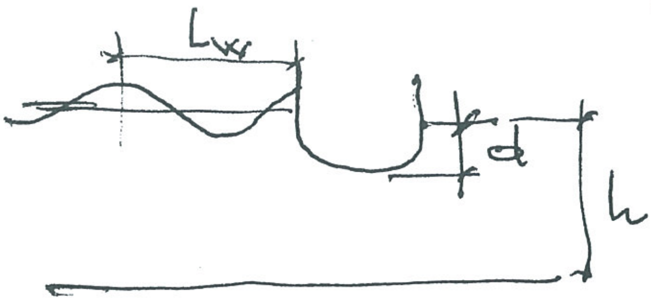
Nel passato dava un altro metodo più complesso

WAGENINGEN

# Onde (probabile ragionamento)




altezza $H \rightarrow H_{1/3}$

lunghezza $L_w$ (periodo $T_w$)

Flusso unitario di energia $E C_g = \frac{1}{8}\rho g H^2 \frac{C}{2}\left(1+\frac{2kh}{Sh\,2kh}\right)$

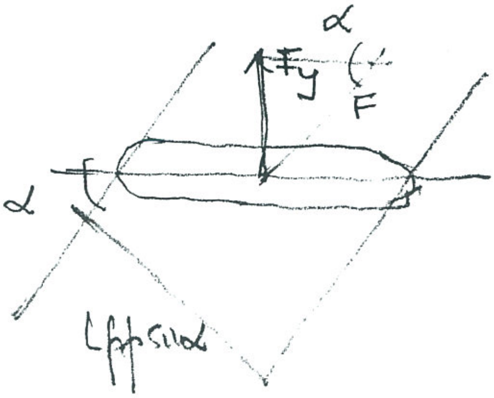
Fl di en intercettato in un periodo $E C_g T_w L_{pp}$ (lavoro).

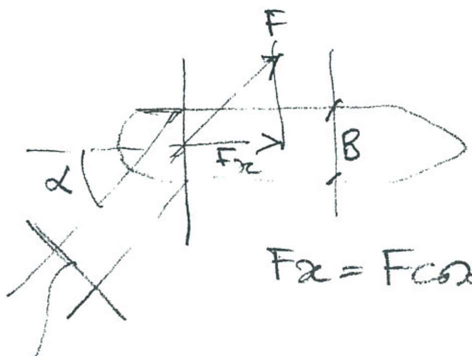
$$\text{Forza} = \frac{\text{Lavoro}}{\text{Lunghezza}} \cdot f\left(\frac{\text{immersione}}{\text{Lunghezza}}\right)$$

Si adotta come lunghezza la $L_w$

$$\text{Forza} = E C_g \frac{T_w}{L_w} L_{pp} \cdot f\left(\frac{d}{L_w}\right) = E \frac{C_g}{C} L_{pp} \underbrace{f\left(\frac{d}{L_w}\right)}_{R}$$

$$= \frac{1}{8}\rho g H^2 \frac{1}{2}\left(1+\underbrace{\frac{2kh}{Sh\,2kh}}_{\mu}\right) L_{pp} R$$




$F_x = F\cos\alpha$

$F_y = F\sin\alpha$

$B\cos\alpha$

$F_y = \frac{1}{16}\rho g H^2 R(1+\mu) L_{pp}\sin\alpha \sin\alpha$

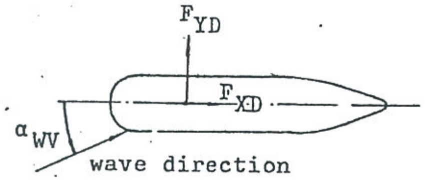
$F_x = \frac{1}{16}\rho g H^2 R(1+\mu) B\cos\alpha \cos\alpha$

2. Mean wave drifting force

The mean wave drifting force on the tankers has been calculated from:

$$F_{YD} = \frac{1}{16} \rho g \bar{H}_{1/3}^{2} . R . (1+\mu) . L_{pp} \, | \sin \alpha_{WV} | \sin \alpha_{WV}$$

$$F_{XD} = \frac{1}{16} \rho g \bar{H}_{1/3}^{2} . R . (1+\mu) . B \, | \cos \alpha_{WV} | \cos \alpha_{WV}$$




$F_{YD}$ = athwart-ships wave drifting force component
$F_{XD}$ = along-ships wave drifting force component
$\rho$ = mass density of sea water
$g$ = acceleration due to gravity
$\bar{H}_{1/3}$ = significant wave height
$L_{pp}$ = length of ship between perpendiculars
$B$ = breadth of ship
$\alpha_{WV}$ = angle of attack of waves relative to ship
$\mu$ = dimensionless water depth coefficient
$R$ = dimensionless drifting force coefficient

The water depth coefficient $\mu$ has been calculated from

$$\mu = \frac{2 k h}{\sinh 2 k h}$$

in which: $k$ = wave number $\frac{2\pi}{L_w}$
$L_w$ = wave length
$h$ = water depth

The wave length $L_w$ depends on the mean period $\bar{T}_W$ and the water depth h, and can be determined from:

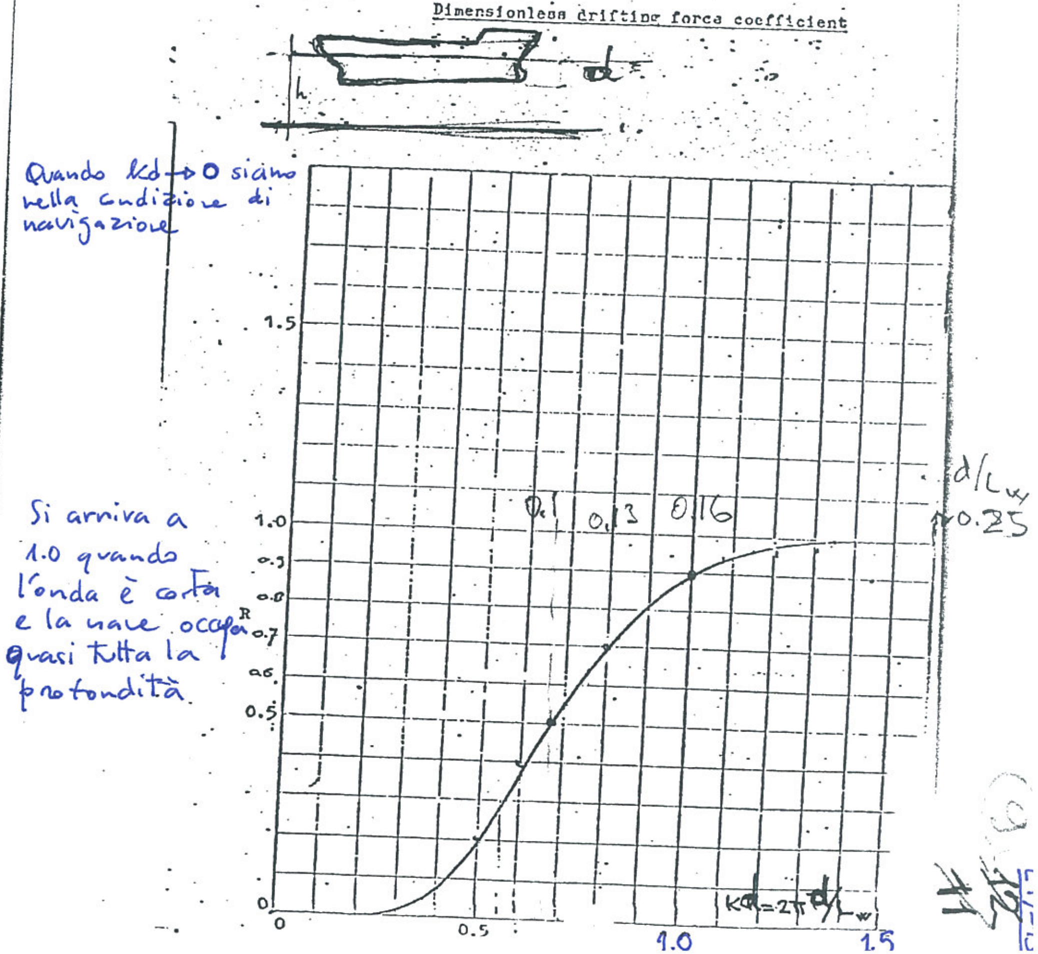
$$L_w = \bar{T}_W . \sqrt{\frac{g}{k} \text{ tangh } k h}$$

In Figure 2 the drifting force coefficient R is given for a captive ship as a function of k.d; in which:
T = draft of the ship

The point of application of the wave drifting force on the ship lies midway between both perpendiculars.

NETHERLANDS SHIP MODEL BASIN WAGENINGEN | Report no. 70-115-GST | Fig.

Dimensionless drifting force coefficient



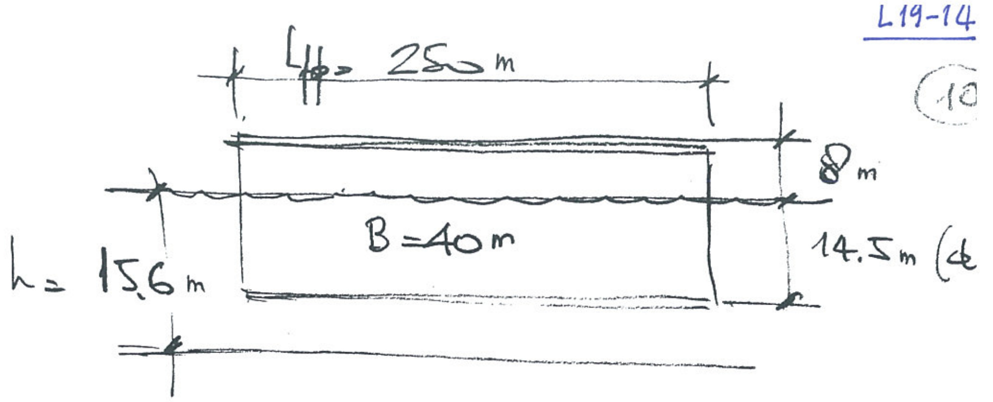
27.03.01



PETROLIERA

100'000 DWT

pieno carico




**Vento** $v = 25\ m/s$ $\rho = 1.2\ kg/m^3$

$A_S = 250 \times 8 = 2000\ m^2$

$F_{y\,max}\ (C = 0.9) = \frac{1}{2}\ 1.2 \times 25^2 \times 2000 \times 0.9 = 675'000\ N \cong 675\ k$

**Corrente** $v = 0.5\ m/s$ $\rho = 1000\ kg/m^3$

$A_S = 250 \times 14.5 = 3625\ m^2$ $h/d = 15.6/14.5 = 1.1$ ; $C = ~~2~~\ 5$

$F_{y\,max} = \frac{1}{2} \cdot 1000 \times 0.3^2 \times 3625 \times 5 =$ ~~906250~~ 815625 N = ~~906~~ 816 kN

**Onde**

$H_S = 2\ m$ $T_w = 10\ s$

$L_{ow} = 156\ m$ $h/L_{ow} = 0.1$ $h/L_w = 0.141$ $L_w = 111\ m$

$2\pi d/L_w = 0.821$ $R = 0.72$

$4\pi h/L_w = 1.722$ $Sh = 2.855$; $1+\mu = 1.603$ $\left(1 + \frac{1.722}{2.855}\right)$

$F_Y = \frac{1}{16} 1000 \cdot 9.81 \cdot 2^2 \cdot 0.72 \cdot 1.603 \cdot 250 \cdot \sin^2\alpha = 707644 \sin^2\alpha\ N$

$F_x = \frac{1}{16} 1000 \cdot 9.81 \cdot 2^2 \cdot 0.72 \times 1.603 \cdot 40 \cdot \cos^2\alpha = 113223 \cos^2\alpha\ N$

| $\alpha$ | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|
| $F_y$ (kN) | 0 | 21 | 83 | 177 | 292 | 415 | 531 | 625 | 686 | 708 |
| $F_x$ (kN) | 113 | 110 | 100 | 85 | 66 | 47 | 28 | 13 | 3 | 0 |
| F $\sqrt{F_x^2+F_y^2}$ | 113 | 112 | 130 | 196 | 299 | 418 | 532 | 625 | 686 | 708 kN |