

10. EFFECT OF WIND FORCE ON MANOEUVRING

10.1 Wind force

Wind force depends on: windage, wind velocity (wind pressure), angle between apparent wind and heading. Wind pressure is proportional to wind velocity squared.

Centre of wind pressure depends on distribution of windage alongside the ship.

Formula for calculating wind force:

$$F = \frac{1}{2} \cdot C_W \cdot A_W \cdot V_W^2$$

Where: C_W = coefficient, depending on the configuration of super structures
(in average $C_W = 0.8$ to 1.1)
 A_W = windage area;
 V_W = relative wind velocity;

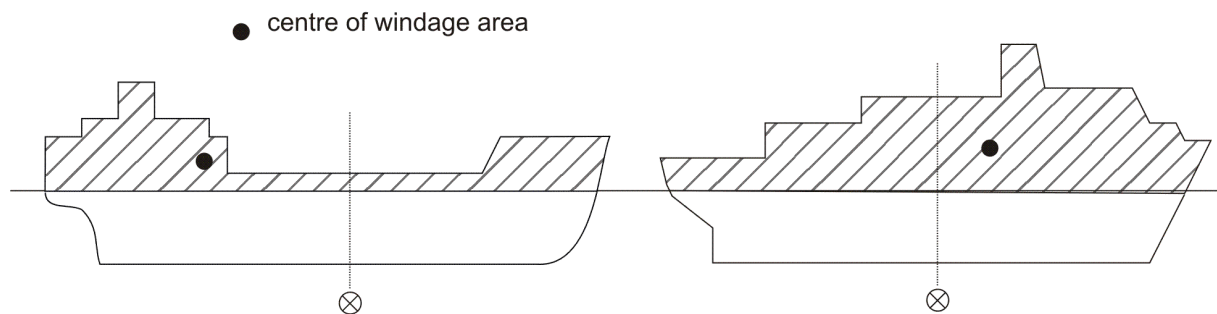


Fig. 10-1 Windage area

Magnitude of wind force depends on wind direction:

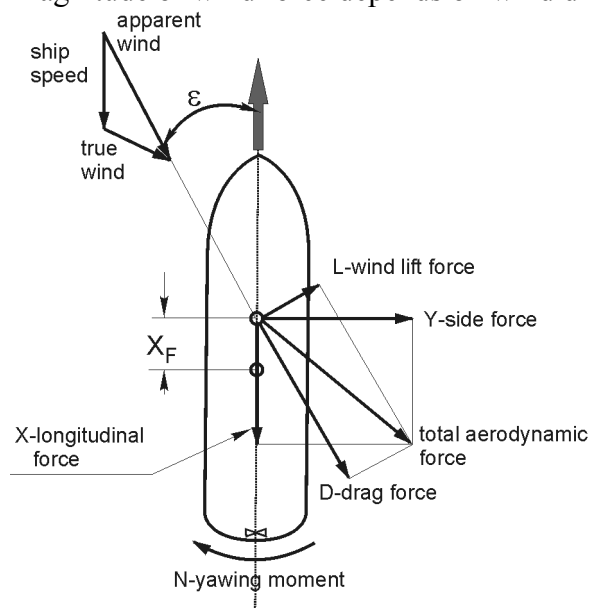


Fig. 10-2 Wind velocities or force components

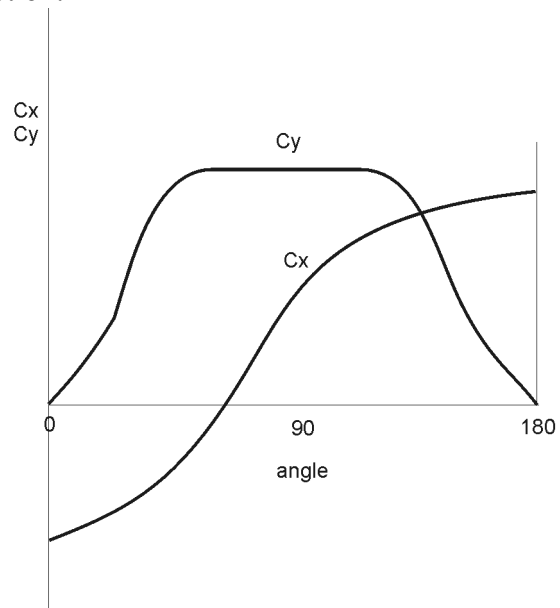


Fig. 10-3 Wind force coefficients depend on direction of apparent wind

10.2 Ship in beam wind

10.2.1 Ship stopped

- Wind force is large.
- There is no longitudinal component.
- Behaviour of the ship depends on the centre of wind pressure, which could be in front or behind of the point of application of transverse resistance force (pivot point). This point is approximately at midship.
- Ship is drifting and turning either way, depending on the relative position of these points.

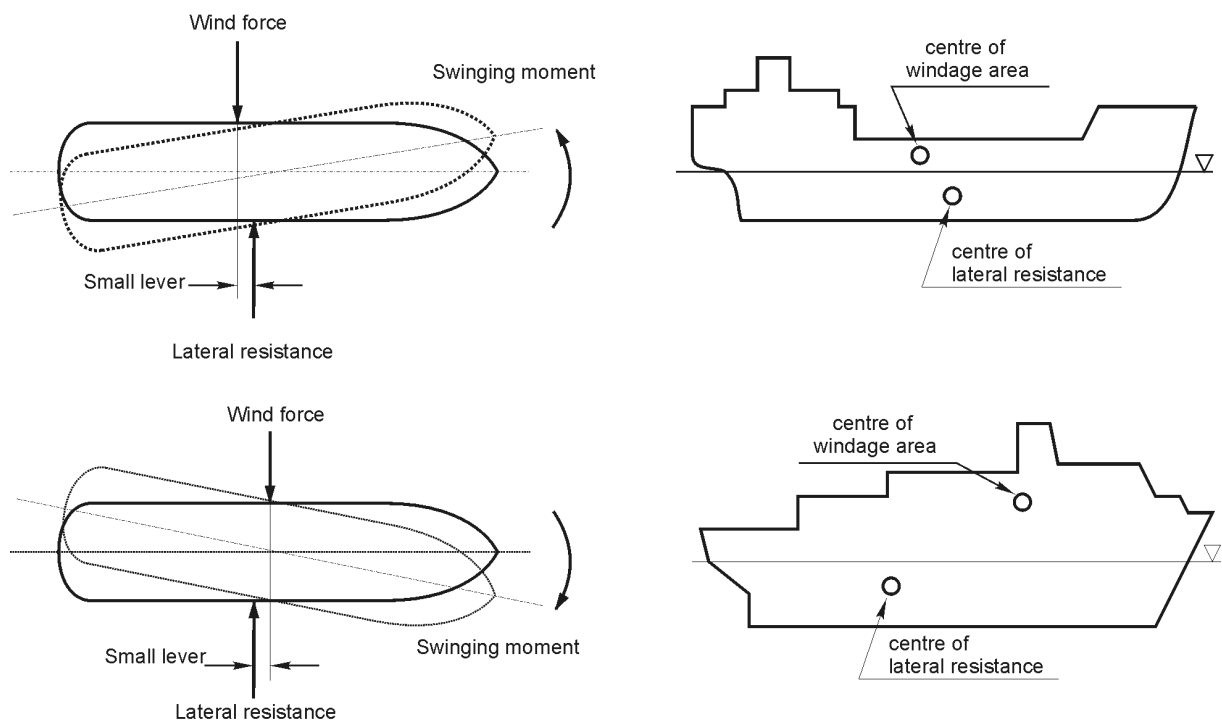


Fig. 10-4

10.2.2 Ship with headway

- Point of application of wind force is behind the pivot point.
- Ship has tendency to swing towards the wind line.

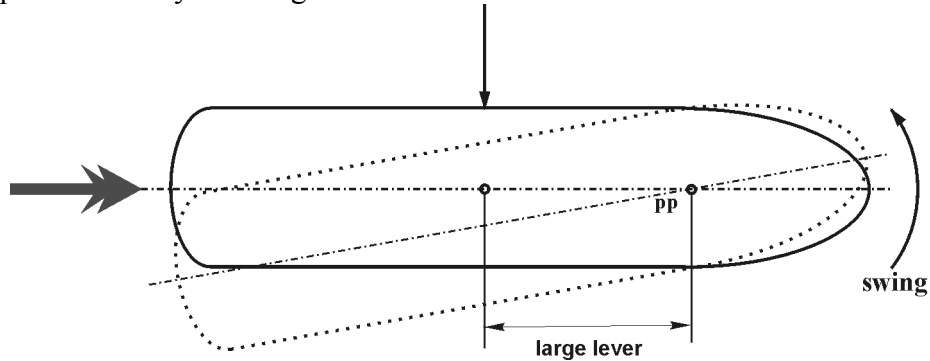


Fig. 10-5

10.2.3 Ship with sternway

- Point of application of wind force is in front of the pivot point.
- Ship has tendency to swing out of the wind line.

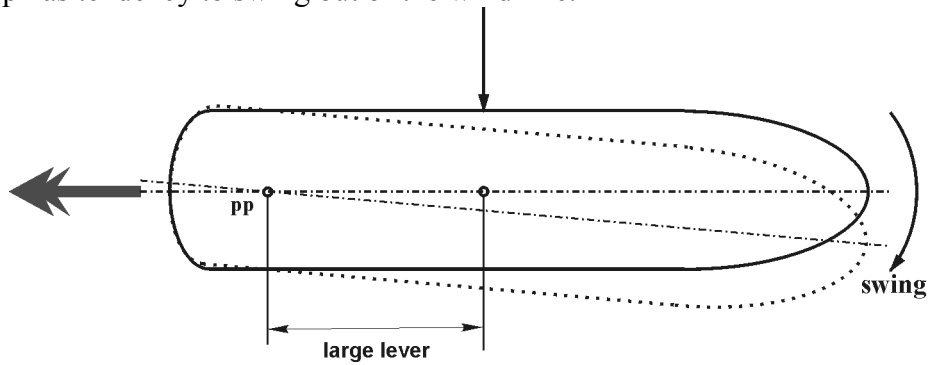


Fig. 10-6

10.3 Wind from bow quarter

10.3.1 Ship with headway

- Point of application of wind force is behind the pivot point.
- Ship has tendency to swing towards the wind line.

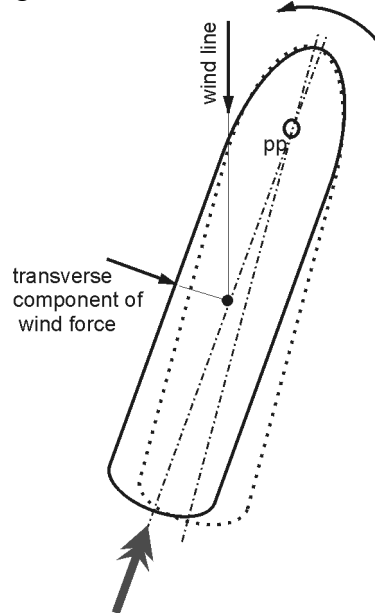


Fig. 10-7

10.3.2 Ship with sternway

- Point of application of wind force is behind the pivot point.
- Ship has tendency to swing towards the wind line.

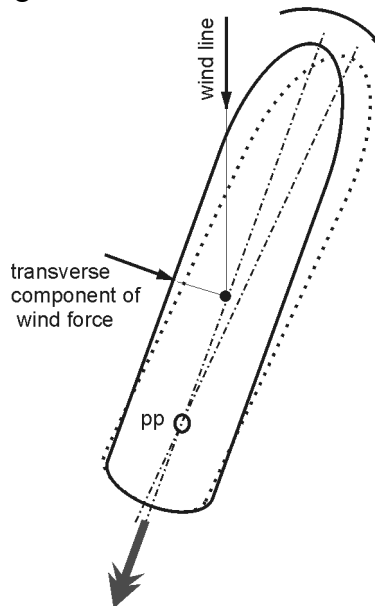


Fig. 10-8

10.4 Following wind

10.4.1 Ship with headway

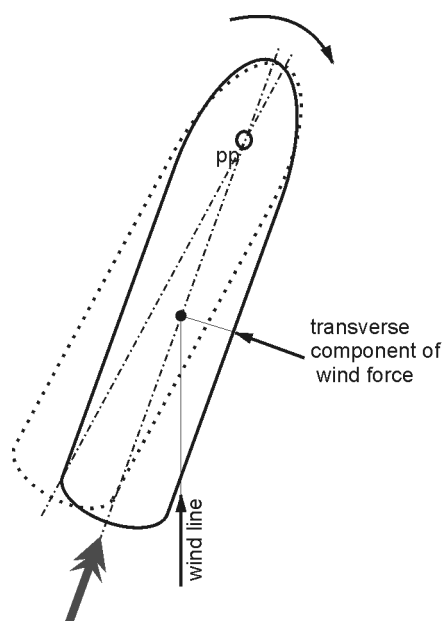


Fig. 10-9

10.4.2 Ship with sternway

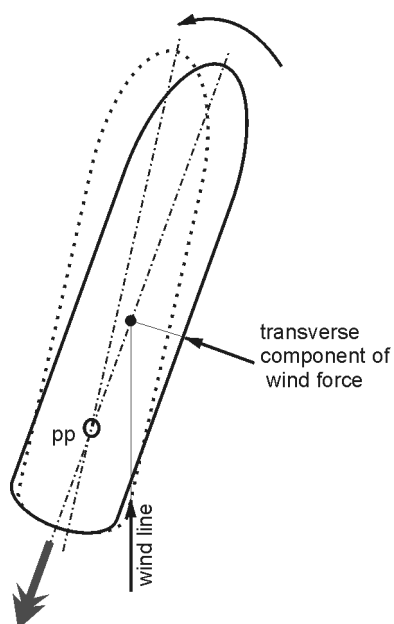
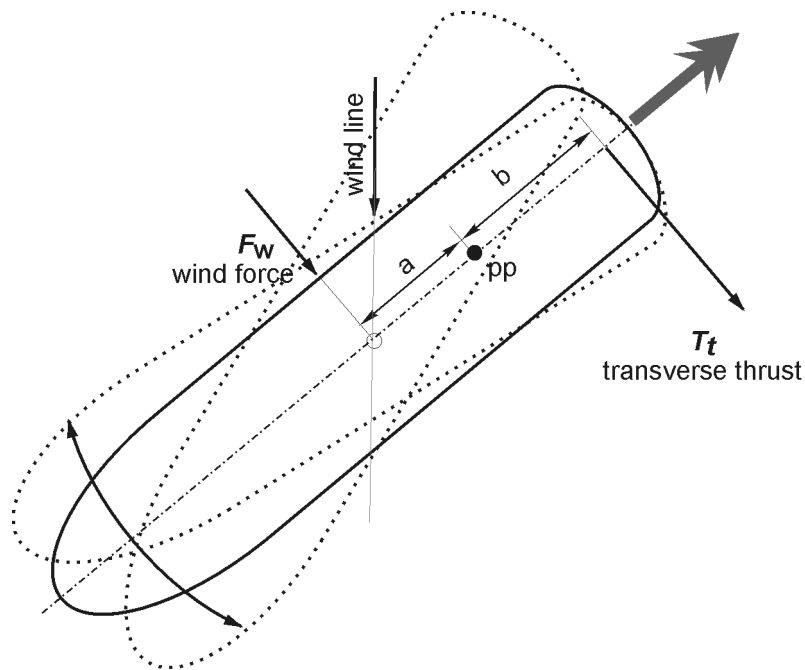


Fig. 10-10

10.4.3 Effect of transverse thrust when backing

- Swing in both ways is possible.
- Behaviour of the ship depends on whether the moment of the wind force ($F_a \cdot a$) is greater or smaller than the moment of the transverse thrust ($T_t \cdot b$).]

**Fig. 10-11**

10.5 Behaviour of the ship in following wind

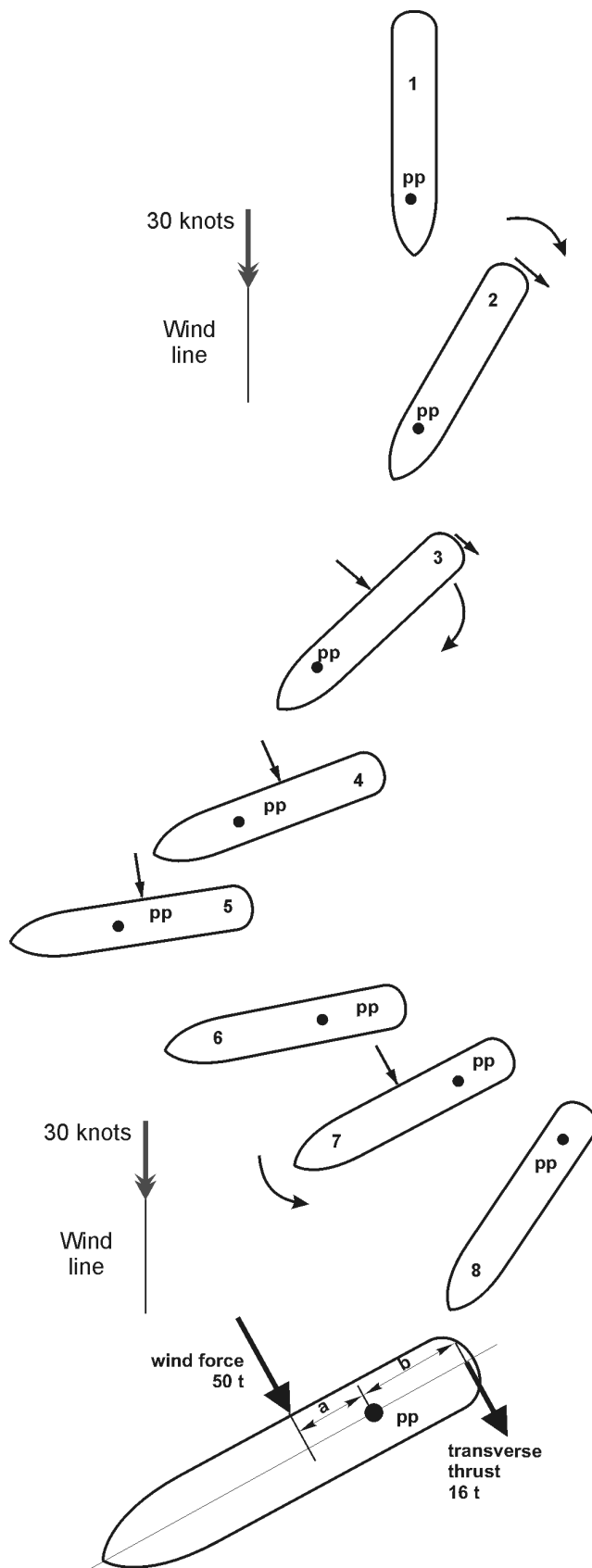


Fig. 10-12

EXAMPLE: 70000 t tanker in 30 knots wind sailing with the wind at 6 knots. She has to be stopped.

Her successive positions:

1. The ship is moving ahead at speed 6 knots, engine is stopped;
2. Engine full astern. Transverse thrust of the propeller working astern pushes stem to port
3. With the wind on the starboard quarter, both wind and transverse thrust cause the ship to Swing to starboard
4. The transverse component of the wind force increases as the ship comes more beam to the wind. Pivot point due to lateral resistance moves back
5. The ship is stopped in the water. Transverse wind force at maximum. The ship moves sideways to port
6. The ship starts moving sternways; the pivot point is shifted towards the stern. The ship moves astern as long as transverse wind force and transverse thrust balance
7. With the pivot point well aft of the midship, a swing to port sets in. The product of wind force and distance to pivot point is more than the product of transverse thrust and distance to pivot point. Transverse thrust could be 10 % of applied stem power (see sketch).
8. The more sternway the faster the Swing to port, the moment of transverse wind force increases and the moment of transverse thrust decreases as the pivot point travels farther aft.