

11. SHIP HANDLING IN CURRENT AND TIDE

11.1 Current forces:

When the ship is moored or held broadside to the current the area exposed to the current is approximately equal to length x draft ($L \times T$).

Formula for calculating current force (in SI units) is:

$$F_{current} = c \cdot \frac{\rho}{2} \cdot L \cdot T \cdot V_C^2 \quad [newtons]$$

where : c - coefficient

ρ - density of water [kg/m^3]

V_C - velocity of current [m/s]

The practical formula for calculation of current force:

$$F_{current} = f \cdot L \cdot T \cdot V^2 \quad [tons]$$

where : V - velocity of current in knot

Coefficient f depends on the clearance under the keel, (due to restricted cross-section under the keel, the pressure on the exposed side increases)

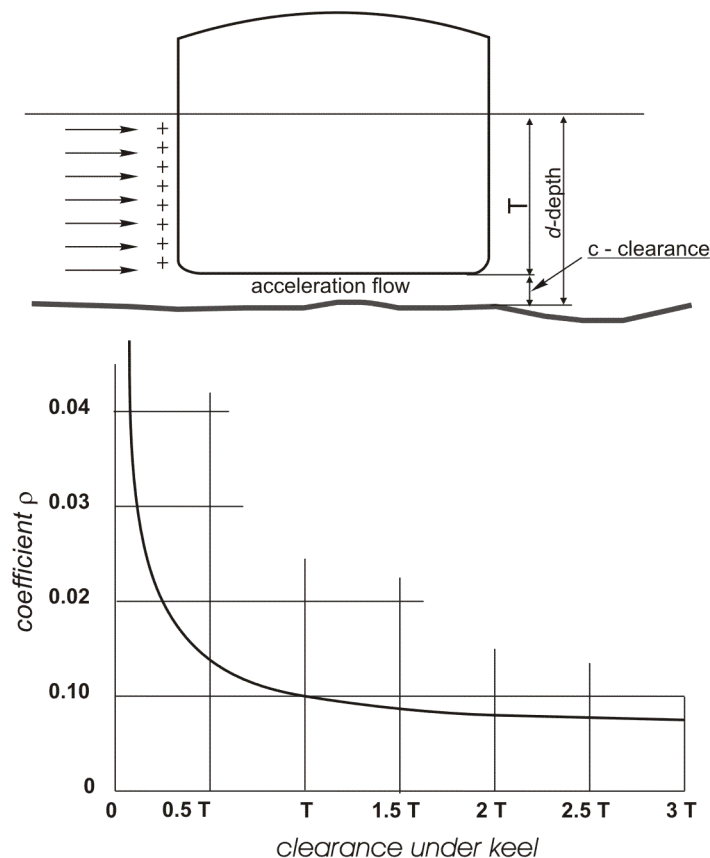


Fig. 11.1

11.2 Area exposed to current:

Due to different underwater profile of bow and stern, the forces at forward and aft perpendiculars are not equal

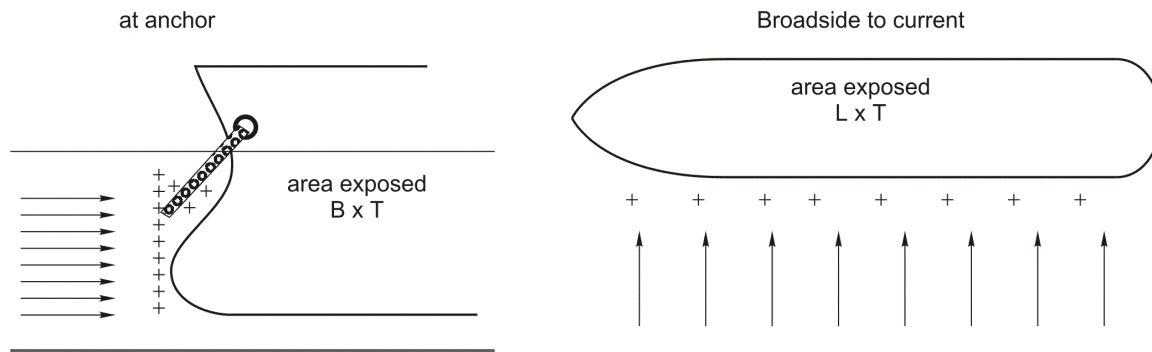


Fig. 11.2

Because of smaller exposed area when at anchor, current forces are much smaller.

Current forces calculated (tons)

ship		current velocity (knots)							
		deep water $d/T=3$				shallow water $d/T=1.1$			
		1	2	3	4	1	2	3	4
VLCC Blue Lady	broadside	53	214	481	854	267	1068	2401	4272
	at anchor	9	38	85	150	47	188	423	751
VLCC ballast condition	broadside	31	124	280	498	156	622	1400	2488
	at anchor	5	22	49	88	27	109	246	438
LCC Warta	broadside	34	136	307	546	171	682	1535	2729
	at anchor	6	24	53	94	29	118	265	471
Container 7200TEU	broadside	36	143	321	572	174	696	1567	2787
	at anchor	5	20	45	80	24	97	218	389

11.3 Manoeuvring in cross current

When the ship is manoeuvring in tide the water surrounding the ship is moving *en masse* together with the ship throughout of this manoeuvre. During certain period of time the ship together with the water is drifting relative to the ground and any fixed objects.

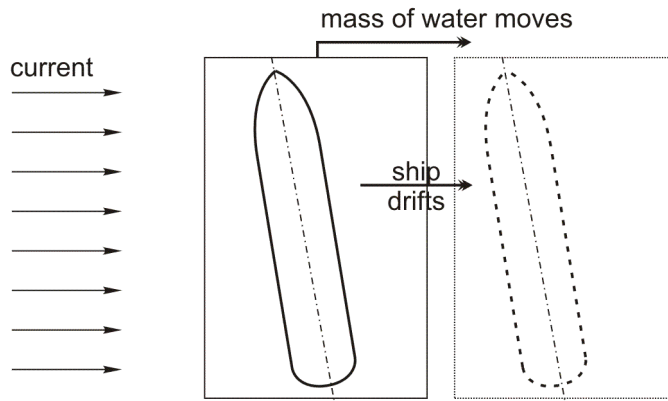


Fig. 11.3

Example:

At 2 knots tide within 15 minutes
ship drifts 1/2 mile over ground

When the ship is moving in cross current the speed over ground is resultant velocity of ship speed and velocity of the current.

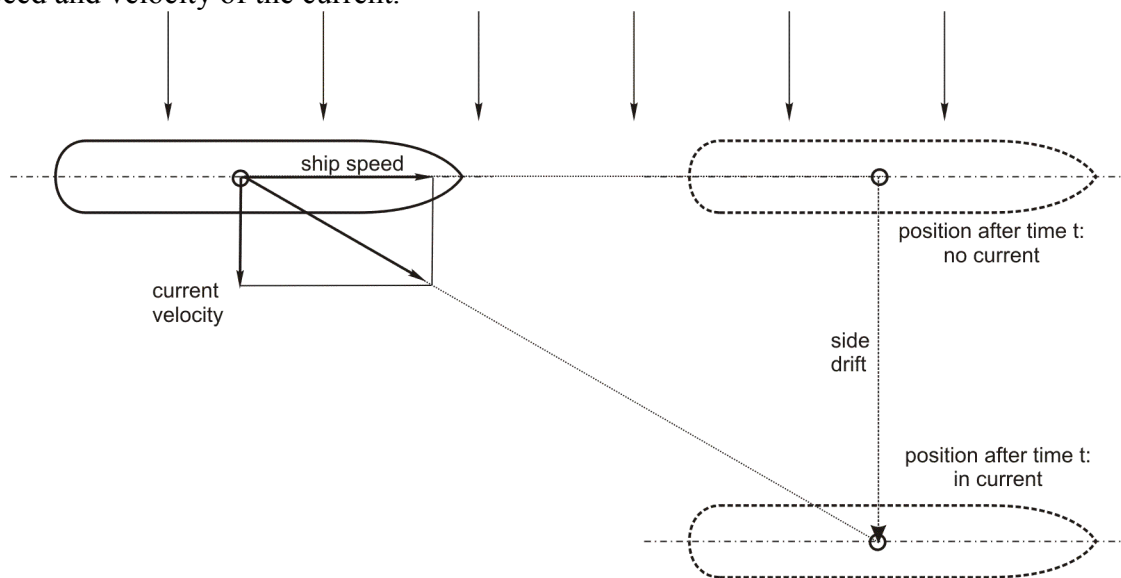


Fig. 11.4

In order to Maintain heading in cross current, the resultant speed has to be taken into account.

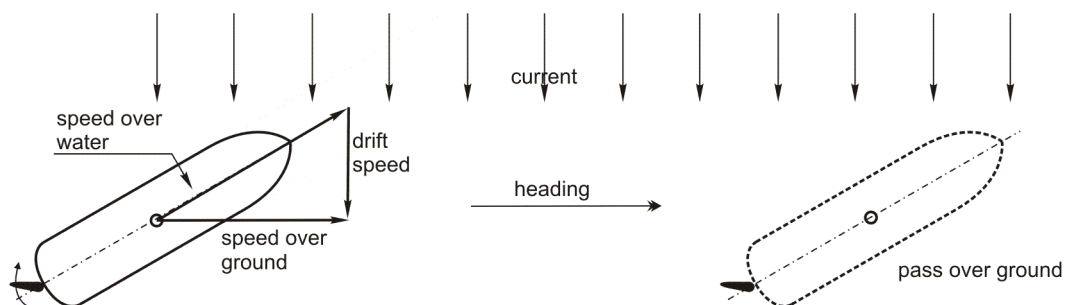


Fig. 11.5

11.4 Manoeuvring in current from ahead and astern

11.4.1 Ship in current from ahead

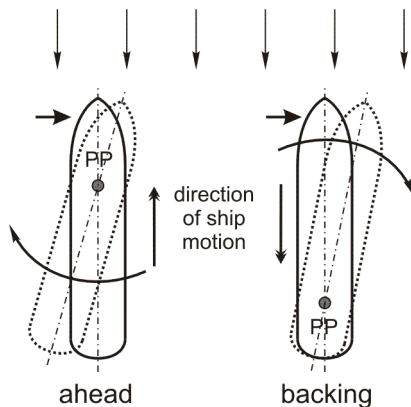


Fig. 11.6

Low revolutions allow maintain low speed over the ground into the tide. Pivot point is forward even the ship is making very slow speed over the ground. Good steering and positive control. When backing pivot point is at stern and control poor.

11.4.2 Ship in current from astern:

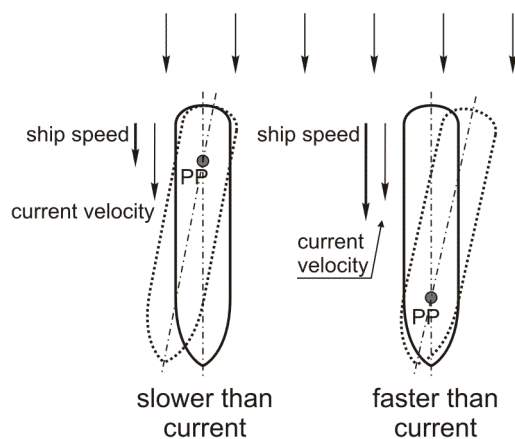


Fig. 11.7

When moving with current in order to maintain the controllability it necessary to run at speed higher than current velocity, which may be too fast over ground. To reduce speed astern order is given and then pivot point is at stern and controllability lost.

11.4.3 Berthing and unberthing in tide:

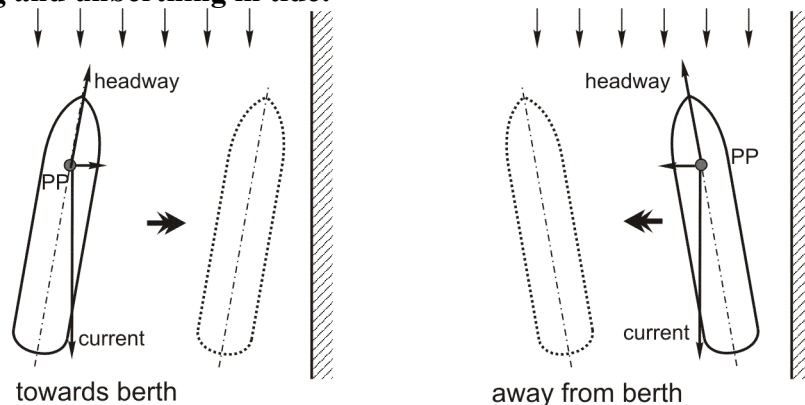


Fig. 11.8

11.5 Working in current in the river estuary with current

11.5.1 Working against the tide in restricted area (river estuary)

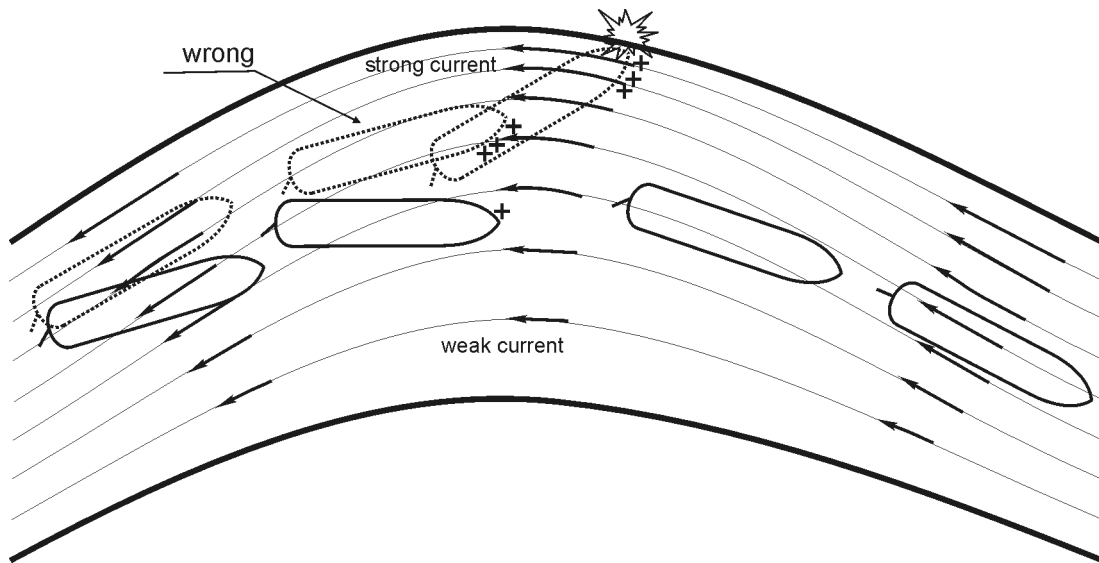


Fig. 11.9

11.5.2 Working with the following tide in restricted area

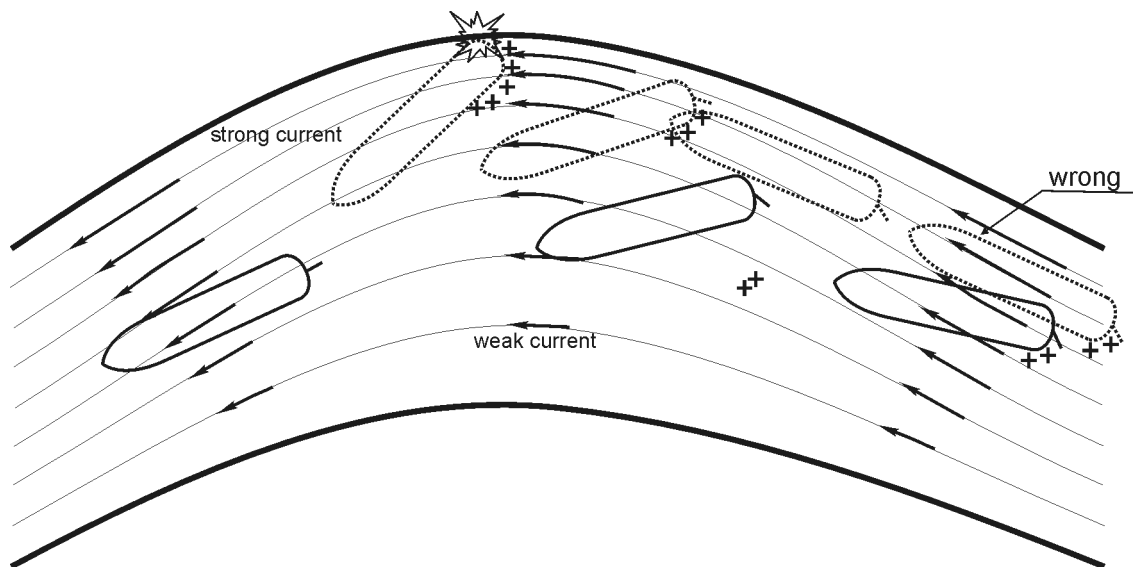


Fig. 11.10

Stronger current close to the outside bank causes the tendency to swing the ship with the stern or bow towards the outside bank, which may create dangerous situation. This might be particularly difficult to overcome when working in following tide because of the small effectiveness of the rudder

11.6 Turning in tide

11.6.1 Turning against the tide in restricted area (river estuary)

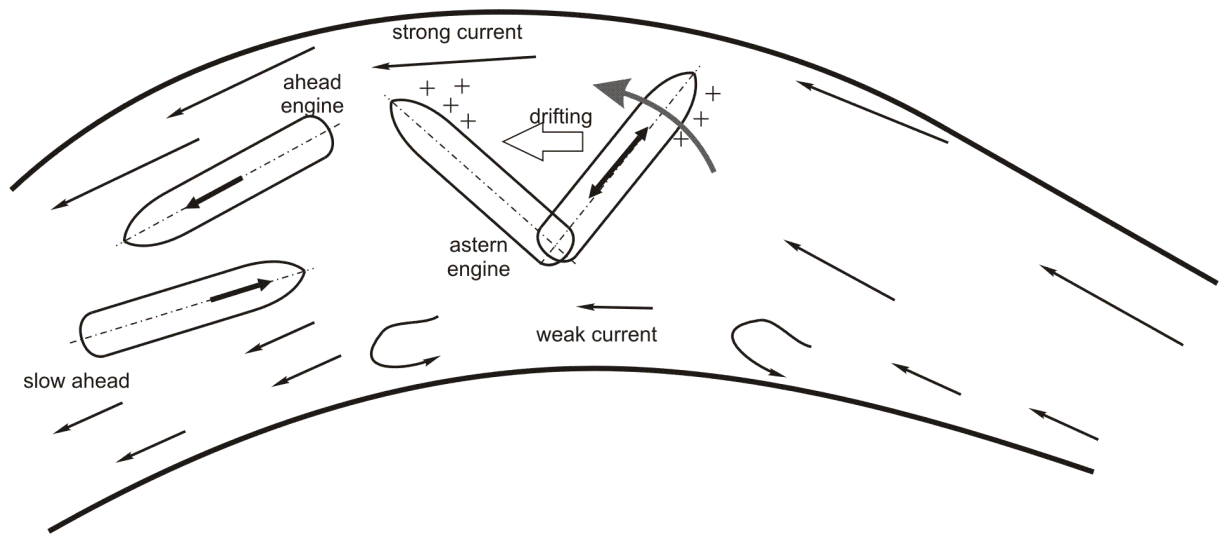


Fig. 11.11

11.6.2 Turning in the following tide in restricted area

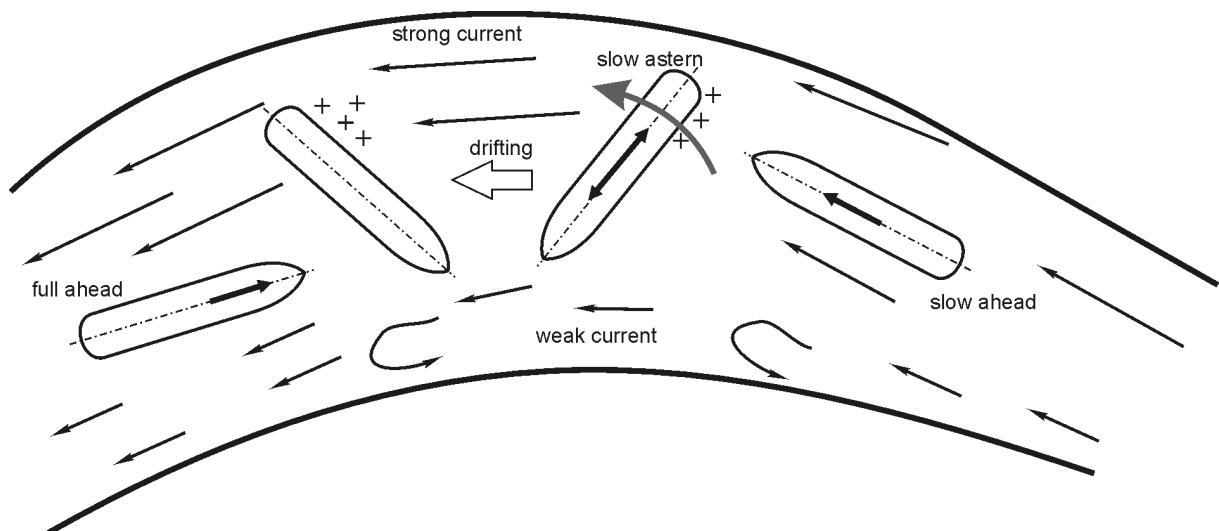


Fig. 11.12

Stronger current close to the outside bank causes the tendency to swing the ship with the stern or bow towards the outside bank. Differences in current velocity are used to accelerate swing.

11.7 Inertia effects when manoeuvring in tide and current

11.7.1 Inertia effect when working in tide

Turning by 90 degrees when working against tide may cause dangerous situation:

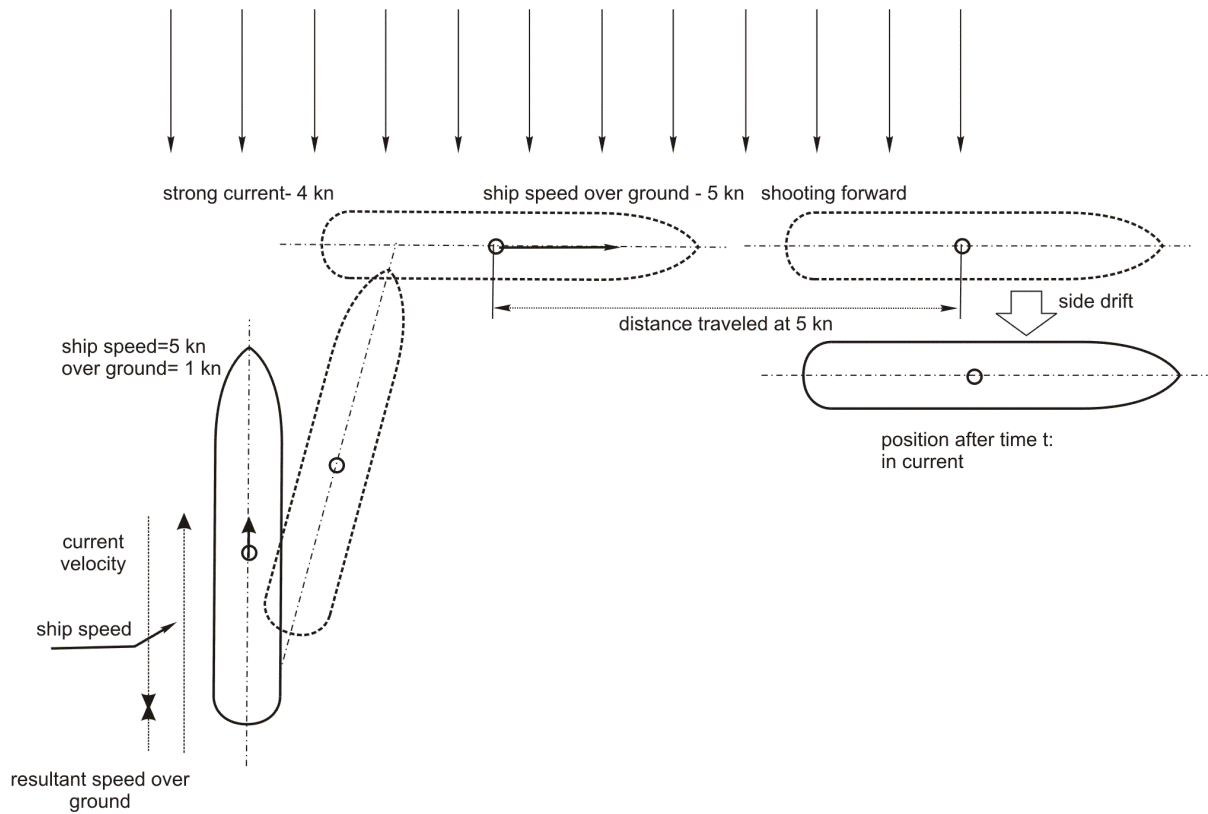


Fig. 11.13

11.7.2 Inertia effect when working in non-uniform current

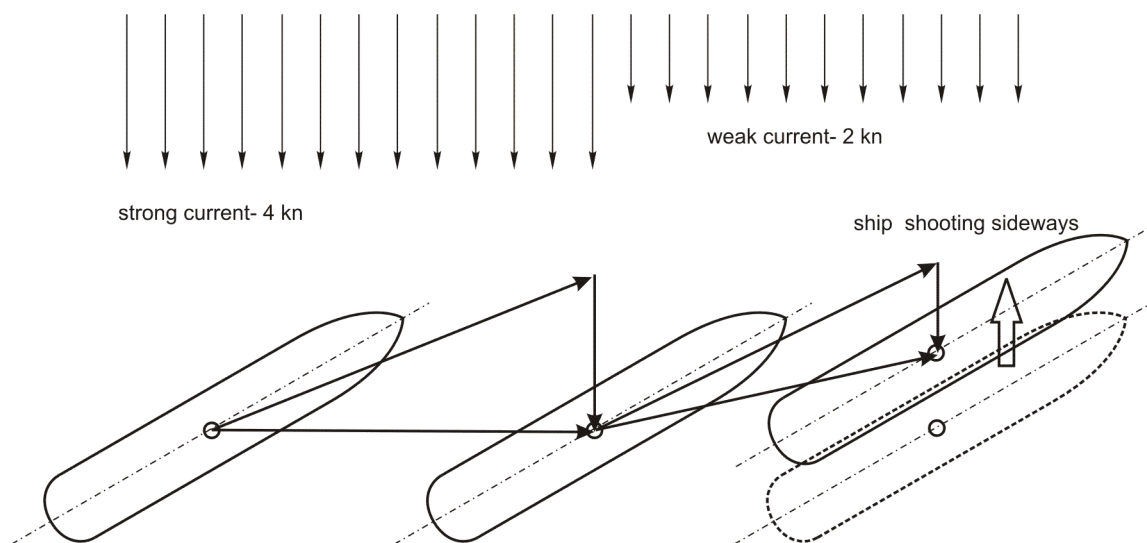


Fig. 11.14

Inertia effects when working against non-uniform current:

A ship proceeding against a current of 4 knots with a speed over water 5 knots makes over ground 1 knot. If it comes to the area where the current is only 1 knot, it makes suddenly 4 knots over ground. If the engine is stopped, inertia is carrying the ship on.

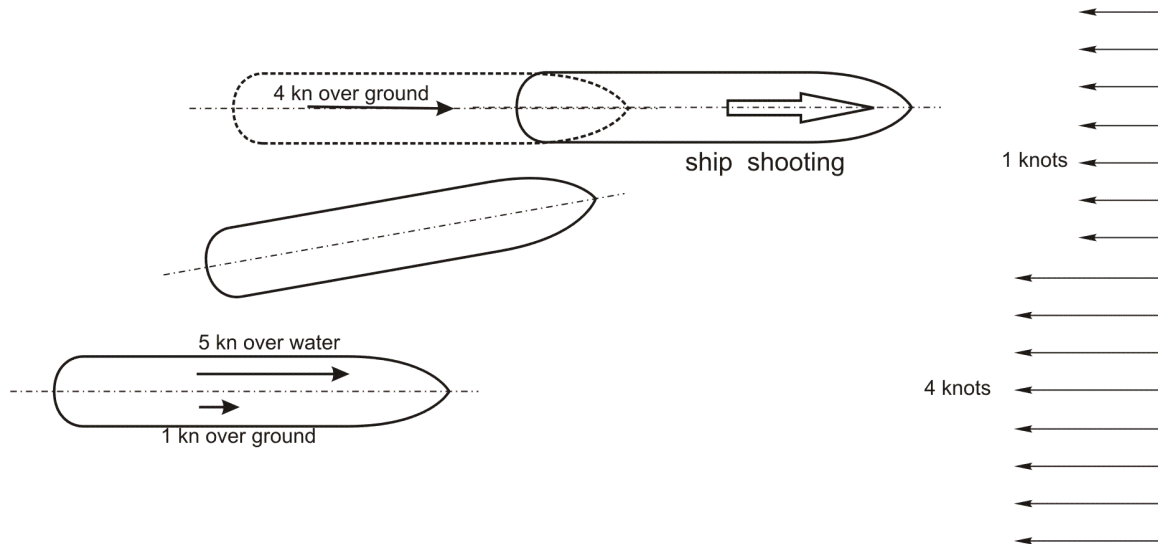


Fig. 11.15

11.7.3 Side moments in head current:

In a head current, engine power is used for steering at zero speed over ground if the ship is proceeding over water at speed equal to speed of current. The ship stays in the same position over ground.

When the ship cants to either side, there will be a transverse component of the speed moving the ship sideways. After some time inertia force is developed

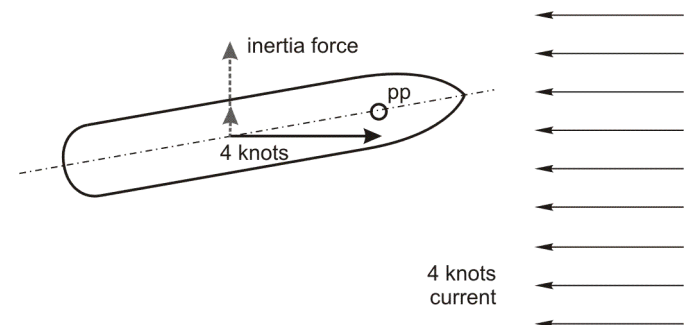


Fig. 11.16

11.8 Current force at anchor

11.8.1 Deep water

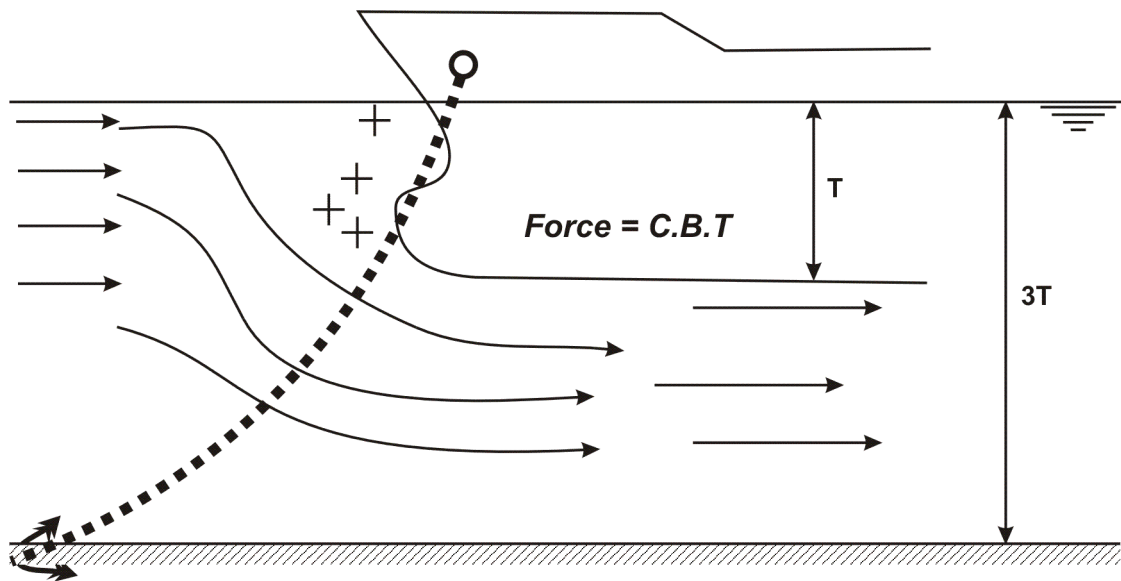


Fig. 11.17

11.8.2 Shallow water:

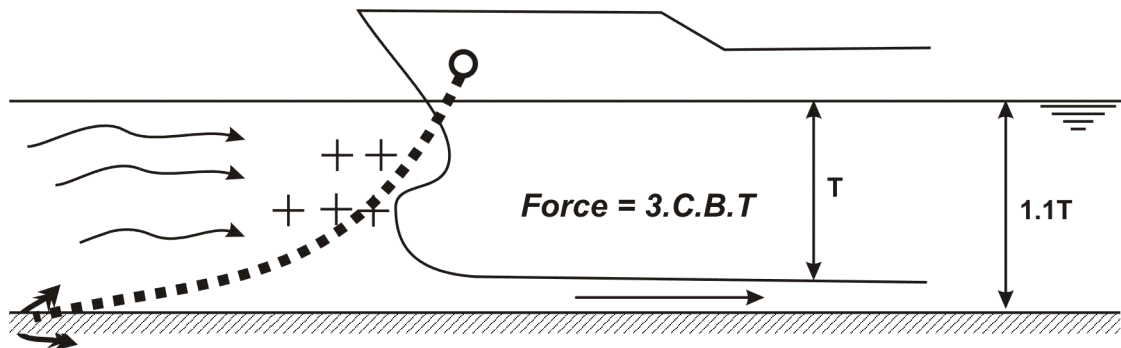


Fig. 11.18

The force exerted by current in a very shallow water is much larger than in deep water because the flow under the keel is restricted.

The force of a very strong current at low water may exceed the holding power of the anchor, especially when there is a strong wind as well.

11.9 Sailing in river

11.9.1 Sailing up the river

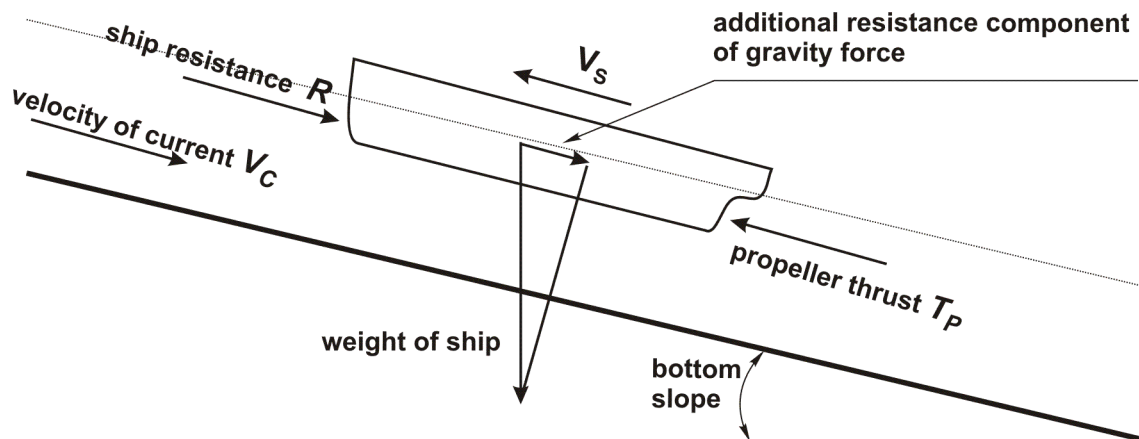


Fig. 11.19

In rivers water surface is sloped;

Slope is measured in meter per kilometre: $1000 \times (\text{m}/\text{km})$

Ship speed over ground is: $V_G = V_S - V_C$

However V_S is Smaller than in calm water because of additional resistance.

11.9.2 Sailing down the river - with current

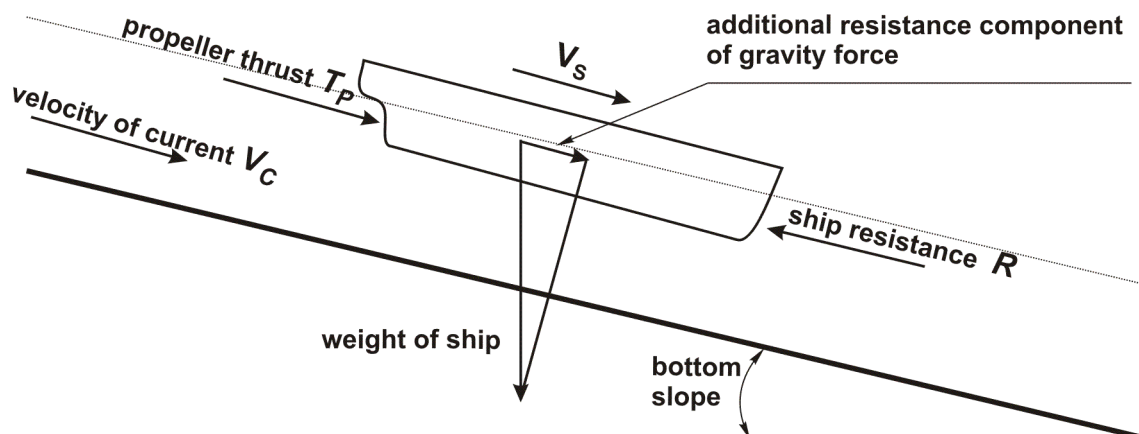


Fig. 11.20

Ship speed over ground is: $V_G = V_S + V_C$

V_S is greater than in calm water because of additional thrust.

Even if there is no propeller thrust (ship without propulsion) additional thrust exists which causes that the ship is moving faster than current.