

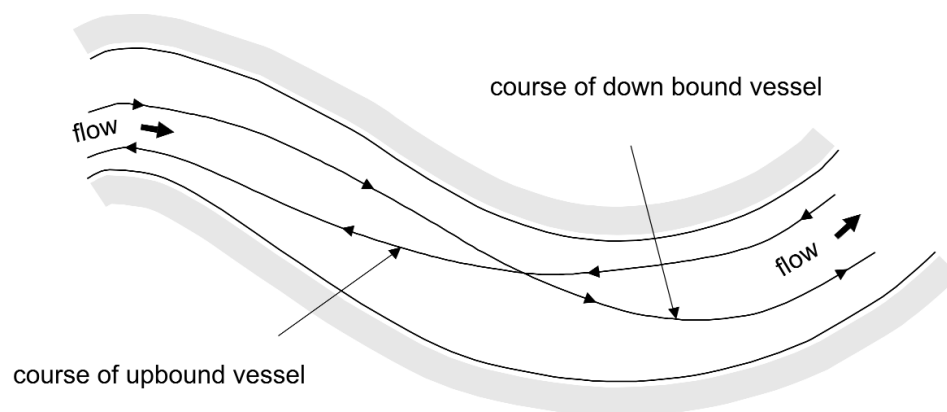
4.2.3). For steady-state conditions, the current may reach a magnitude of two to five per cent of the wind speed, whereas the effect on the water levels can usually be neglected, unless the fetch length is considerable (see Section 4.2.4.6).

#### Navigation, ship-induced currents and waves

The impacts of waves on the cross-sectional design should be considered in terms of the crest levels, slope angles and the extent of bed protection works. On rivers, the techniques of navigation vary considerably from those in a canal and should be considered accordingly in the design. Ship-induced hydraulic loadings acting on an inland waterway structure are:

- return current (see Section 4.3.4.1)
- water level depression and front wave (see Section 4.3.4.1)
- stern and secondary or interference waves (see Section 4.3.4.2).

As shown in Figure 8.21, an upbound vessel often navigates in the portion of channel where the stream velocity is lower, to save fuel and increase speed. By contrast, a vessel heading downstream generally navigates in the maximum flow. Several ship positions may need to be considered in the design. The designer should take into account local practices and regulations to establish the effect on channel and bank stability (see Section 8.3.5 for similar considerations for canals).



**Figure 8.21** Typical navigation courses

Table 8.2 indicates typical values for a number of hydraulic loads. These values should be used as a guide only. More accurate and site-specific data should be obtained for detailed design.

**Table 8.2** Typical values of hydraulic loads

Situation	Return ( $U_r$ ) or natural current	Water level depression		Secondary waves		Wind waves	
	Velocity (m/s)	Height $\Delta h$ (m)	Period $T$ (s)	Height $H_1$ (m)	Period $T$ (s)	Height $H$ (m)	Period $T$ (s)
Small river and restricted navigable channel	1.0–2.0 *	0.5–0.75	20–60	0.5	2–5	0.5	2
Large navigable channel	2.0	1.0	20–60	1.0	2–5	1.0	3–4
Large river and estuary	3.0–4.0	1.0	20–60	1.0	2–5	1.5–2.0	5–6

#### Note

\* Natural current velocities in steep upper reaches of rivers can be as much as 4 m/s.