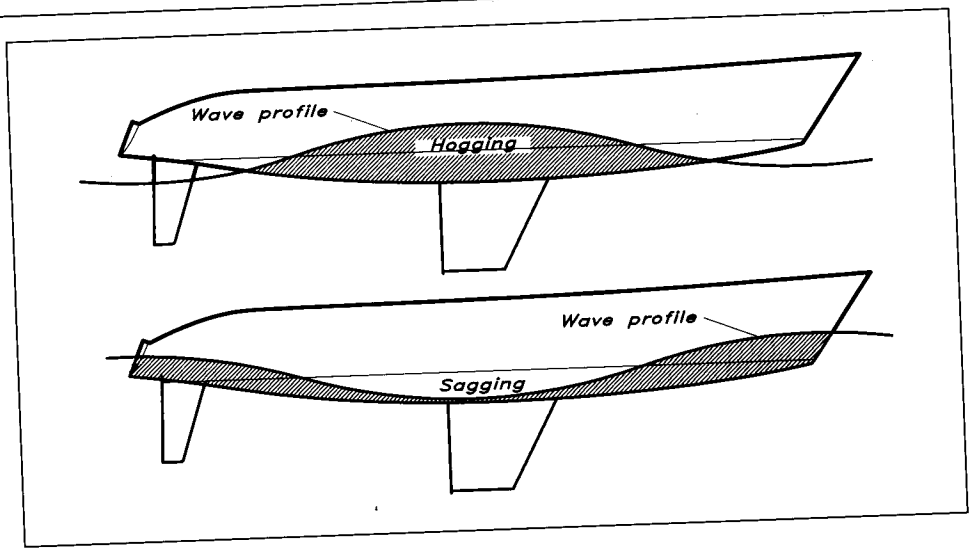

Fig 4.18 *Hogging and sagging*

mentioned that the effect is often the opposite for a ship with vertical sides at midship.)

For the wave profile effect to be significant the wavelength has to be of the same order as the hull length. This is not the case at sea, at least not under difficult conditions, where the waves are much longer. On the other hand, the waves generated by the hull itself often have the same length as the hull (as we will see in Chapter 5). The hull is then in a sagging condition and this may reduce stability considerably, particularly for hulls with a shallow draft, where the maximum beam may be much reduced in the wave trough. A formula for this effect will be given in the final section in this chapter.

To understand the effect of centrifugal forces some knowledge is required about the particle motion in the waves. This is explained in Fig 4.19. When the wave passes a certain point on the surface the water particles exhibit an orbital motion. Thus, when the particle is in a wave crest it moves with the wave, while the opposite is true in a wave trough. It is easy to compute the orbital speed, since the diameter of the circle is equal to the wave height, and the time to complete one full turn is equal to the wave period. For ocean waves this speed may be several metres per second.

The centrifugal effect on the water particles is explained in the lower part of Fig 4.19. In a crest the centrifugal force is directed upwards, ie opposite to the gravitational force; while in a trough the two forces are in the same direction. An extreme case is when the two forces are equally large, which may happen for short and steep waves. Gravitation is then cancelled in the wave crest and the water will no longer be continuous, but break down into droplets. A hull in this position will lose all its stability. A relevant question is whether it will still stay afloat, and the answer is yes (provided it does not capsize). It will, in fact, float at the original waterline. This is because the hull loses as much weight as the water due to the circular motion.

Complete loss of stability is, fortunately, very rare, but significant