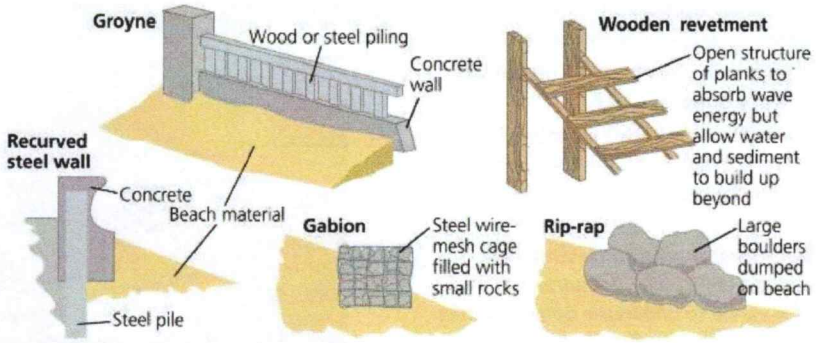

Figure 3.40 Examples of hard engineering solutions

Traditional approaches to coastal erosion and flood risk

Hard engineering

Hard engineering generally involves making a physical change to the coastal landscape using resistant materials, like concrete, boulders, wood and metal. Often each strategy is large scale and costs a significant amount of money. Each type of hard sea defence is built with a specific purpose (Figure 3.40):

- **Sea walls** (sometimes **recurved**) aim to dissipate wave energy. The recurved structure throws waves back out to sea, into the path of the next incoming wave, thus also reducing its wave impact. Sea walls also provide a physical barrier to flooding by raising the height of the coastline. Sea walls must have a continuous facing because any slight gap will be exploited by hydraulic action. They also need drain outlets so that any water that does get over them does not accumulate inland.
- **Rock armour** (rip-rap) consists of large boulders dumped in front of a cliff or sea wall to take the full force of the waves. The boulders are deliberately left angular in appearance to present a large surface area to the waves, and create gaps for water to filter through, again mitigating their impact on the coast. Usually the boulders are not secured in place so energy is taken out of the most powerful waves by rocking or slightly moving the massive rocks.
- **Gabions** operate on the same principle as rip-raps, but smaller boulders are contained within steel wire-mesh cages, each of which can be joined together to form larger structures, or walls.
- **Revetments** are concrete or wooden structures placed across a beach or coastline to take the full force of the wave energy, preventing further erosion of the coast.
- **Groynes** are wooden, stone or steel breakwaters built nearly at right angles to waves (usually 5 to 10° from the perpendicular to prevent scouring on the down-drift side of the groyne). They are built to control longshore drift by trapping sediment to create higher and wider beaches which will then also dissipate wave energy. The groynes themselves will also break up the waves as they hit the coast. Halting the bulk of longshore drift in an area may have serious effects down the coast where it will cut off the supply of beach material and could leave the coast there exposed to erosion.
- **Cliff fixing** is often done by driving iron bars into the cliff face, both to stabilise it and to absorb some wave power.
- **Offshore reefs** force the waves to break offshore, which reduces their impact on the base of cliffs. In some places redundant ships have been deliberately sunk parallel to the shore to both slow down approaching waves, and to act as a substructure for reef material to begin to colonise.
- **Barrages** are large structures built to prevent flooding on major estuaries and other large sea inlets. A barrage acts as a dam across an estuary and prevents incursion of seawater. Good examples of barrages are those that are part of the Delta Plan in the Netherlands and the Cardiff Bay barrage in Wales which was completed in 1999.

Hard engineering strategies are generally long lasting and effective over their planned lifespan; however they do have several disadvantages, including:

- structures can be expensive to build and to maintain (to repair a sea wall can cost over £5,000/m)
- defence in one place can have serious consequences for another area of the coast
- structures are sometimes an eyesore, spoiling the landscape and physically disrupting natural habitats.

The coastal town of Morecambe in Lancashire is used as an illustrative example of the use of hard engineering strategies.