## 5.8 QUAYS

The construction of quays falls broadly into two classifications: quays with a closed or solid construction, and quays with an open construction, where the deck is supported on piles. A key element inside a typical fishing harbour, however, is the draft, ranging from 1.5 metres to 6 metres may be required, depending on the type, size and number of resident fishing vessels. An artisanal fishing port hosting small fishing vessels having a loaded draft of no more than 1 metre would not normally require a draft of more than 1.5 metres at low tide unless large vessels visit the port during the peak fishing season.

**Solid quays – minimum draft 1.5 metres**

The earth-retaining structure, as the quay wall is known, consists of a number of layers of concrete-filled jute bags placed on a rubble foundation in a brickwall fashion. This structure does not require any major cranage and may be built with the sole assistance of one or two divers. The major advantage of this type of construction is that an uneven sea bed or large boulders can be included in the foundation. The jute bags should be filled with just enough concrete to form a pillow of uniform thickness. Overstuffed bags, item B, should not be incorporated into the wall. Prior to commencing such work, a temporary guide frame should be built as shown in the construction method for solid breakwaters. The frame can be in scaffold pipes, bamboo or other timber sections.

Granular material only (no silt, mud or clay) should be used as backfill and the top surface should be blinded or sealed with graded aggregate. The blinding should be compacted properly using a vibrating plate compactor. The front or toe of the quay should also be protected against scour by both propellers and tidal streams. This protection can consist of concrete-filled jute bags laid side by side over the screeded rubble. The concrete capping block should be cast in situ after the granular backfill has been placed. Each capping block should not be more than 5 metres long and should contain some reinforcement.

**Solid quays – minimum draft 3 metres**

Concrete blockwork quay built from concrete blocks placed by a crane on a screeded bed of stone rubble. This kind of earth-retaining structure is very common but requires the use of a suitable crane. The crane can either be the floating type or terrestrial. The concrete blocks are first cast in a yard and after 28 days have elapsed, they are lifted and placed on the sea bed. The blocks are placed to form pillars on the screeded rubble. The block pillars should be kept about 50 mm apart in such a way that each pillar may settle without rubbing against adjacent pillars. To achieve this, it is common to nail wooden spacers, 50 mm thick, to one side of the blocks prior to placing. Slings may either pass underneath the block or lift the block via hooks. The slings may be in wire rope or chain and the factor of safety in the lifting apparatus for safe working loads is 8. Some countries require a higher value to take the wear-and-tear of the slings into consideration.

**Solid quays – minimum draft 6 metres and beyond**

The cross-section may be adapted for a quay with a draft of 6 metres by increasing the size and width of the concrete blocks; however, the required size of the blocks would be so large as to require very large and heavy lifting equipment. A more economical solution in terms of the equipment required. The earth-retaining structure in this case is a special corrugated sheet of steel, known as a sheet pile, which interlocks with adjacent units to form a continuous wall. This wall is driven into the sea bed, sheet pile by sheet pile, and the top tied back to an anchor wall, which may consist of a slab of reinforced concrete or a length of the same bulkhead. A temporary timber or steel guide frame is generally erected to help drive the sheet piles vertical and in a straight line. The crane used to drive sheet piles must have a long jib to enable it to pick entire lengths of sheet pile for driving.

The crane may either be mounted on a barge, in which case the sheet piles are driven from the sea side of the bulkhead, or driven over a temporary reclamation and driven from the rear of the bulkhead. The temporary reclamation may then be used as

backfill. Sheet piles are suitable for driving into clay, sand and silt deposits, as well as some types of coral. Sheet piles cannot be driven in most types of rock and in the presence of large boulders. Hammers for driving sheet piles may be of two types: impact hammers or high-frequency hammers. Impact hammers, as their name suggests, are hammers which impart an impact to the sheet pile. In the presence of soft deposits or clay, impact hammers do not pose any problem. In the presence of difficult ground, however, such as when sand contains large boulders, the impact from the hammer may damage or bend the sheet pile.

**Open quays – minimum draft 1.5 metres**

The deck of an open quay is supported on piles and the whole structure is open to full view. In view of this, an open structure is considered to be more delicate than a solid one and special fendering measures have to be incorporated in the design to prevent damage to the structure. Open quays may be constructed entirely in timber, concrete or steel, or a mixture of the three. Timber, however, may be attacked by insects. It illustrates how an artisanal open quay may be built using mainly locally available materials, such as timber or steel pipes. Given the small dimensions of the structure, a crane may not be needed if a light lattice tower or tripod and a piling winch are available to drive the piles. The figure also demonstrates the manner in which the pile heads should be prepared to receive the cross-beams. The timber used in such a structure should be the right kind of timber and treated against decay and attack by insects.

**Open quays – minimum draft 3 metres and beyond**

Conventional, deeper water open quays of the type traditionally found in larger fishing ports. The structures are typically subdivided into two categories: with and without tidal variation. Cross-section without tidal variation, where the impact load from a vessel is transmitted directly to the deck of the quay via a simple rubber fender. The open quay, in this case, is fronted by another structure, the rubbing fender pile, which has to absorb the impact from a vessel mooring at low tide without damaging the main quay piles immediately behind it. If the quay wall is solid (sheet piles), then

timber or rubber strips are applied to the sheet pile for the vessels to rub against. Piled quays are particularly effective at absorbing wave energy due to the presence of the rubble slope underneath the deck. The rubble is normally similar to a breakwater grading, requiring core material (1–100 kilograms), armouring (200–1 000 kilograms) and toe berm (1 000–2 000 kilograms) to prevent scour damage. If the reclamation behind the piled structure is not sealed properly with a geotextile membrane, fines tend to leach out of the rubble, leading to uneven settlement of the apron.

The piles may either be in normally reinforced concrete, prestressed concrete, or steel. Whereas most concrete piles are solid, steel piles are usually hollow pipes. In most cases, if only small lengths of pile can be handled by the crane, piles can be jointed in situ to form longer lengths as required. Concrete piles are generally glued with special epoxy glues, whereas steel piles are commonly welded together via simple butt-joints. If hollow pipes are used, these may either be filled up with concrete and reinforcing steel (to prevent corrosion on the inside and add strength to the pile) or, if the pipe thickness is enough, left as open-ended piles.