7.2.1.3 Control room and winch house

The control room should be situated such that the operator has a clear view of the ship for recovery and launching. This should ideally be at the head of the slipway.

7.2.1.4 Ground conditions

The ground conditions should be assessed as part of the study optimizing the location of the slipway.

The underwater length of the slipway should be constructed in dry conditions to achieve the required construction tolerances and quality. The ground conditions should be assessed to determine whether construction of a temporary cofferdam and associated dewatering works is viable.

7.2.1.5 Water depths

The slipway should ideally be located in an area of natural deep water to preclude capital dredging and possibly maintenance dredging.

Provision should be made for sufficient depth of water at the end of a launchway to give clearance under the ship during the launch. The depth should be as specified by the ship designer.

7.2.1.6 Dry berths

Dry berths comprising concrete slab structures should be provided at the landward end of the slipway above highest water level, to allow shipbuilding and ship repair to be carried out in dry conditions. The plan area of the dry berths should be determined by the maximum size of ship. Sufficient space should be provided to allow for piped and electrical services take-off points, temporary staging, scaffolding, mobile plant and crane access as required.

Anchorages should be provided at the dry berths to restrain the ship when recovered and prevent it from running back down the slipway. The hauling winch should not be used to restrain the ship in the permanent situation.

A ship transfer system should be provided where the required throughput demands a greater number of dry berths to be accessed by ships than are provided at the top of slipway rails.

Space should be provided for the storage of spare carriages when not in use.

A system of drains and bunds should be provided to allow for the collection and disposal of contaminated water and waste material.

7.2.1.7 Lead-in structures

To enable ships to be controlled either when being manoeuvred over the carriages for retrieval or after being refloated at relaunch, a lead-in structure should be provided. This should be on at least one side of the slipway, in exposed locations, it should be on both sides.

7.2.2 Shipbuilding berths

7.2.2.1 Dry berth above MHWN

The inclined dry shipbuilding berth should be located such that operations on the berth can be undertaken without significant disruption from high water levels.

7.2.2.2 Berth below MHWN

The inclined berth structure should extend to a level below MHWN and for the economy of construction should terminate no lower than mean low water springs (MLWS).

7.2.2.3 Water depth

An area of water of sufficient depth should be provided beyond the lower end of the inclined berth such that:

- the water depth immediately adjacent to the inclined berth permits the upper end of the ship (usually the bow) to submerge dynamically until sufficient buoyancy counteracts the associated energy;
- the water depth for the lower end of the ship (usually the stern) provides buoyancy lift (stern lift);
- the ship can be brought to a stationary buoyant condition safely.

7.2.2.4 Gated berths

Where the site constraints, in particular small tide variation, make it impractical to provide the water depths for a simple dynamic launch, a gated berth should enable the lower end of the berth to be flooded prior to launch.

The design of the area of the gated berth which is below highest astronomical tide (HAT) should be in accordance with Clause **5**.

7.3 Elements of slipways and shipbuilding berths

7.3.1 Slipways

7.3.1.1 Components

The design of a slipway should include the following components:

- lead-in structures;
- civil works foundations and support structures;
- rail system;
- carriages;
- hauling system;
- control system;
- dry berths;
- piped and electrical services.

Where appropriate, a transfer system should be included.

7.3.1.2 Loads

The slipway loads should be expressed as a set of wheel loads acting on the rails.

The position of maximum load and the load distribution varies with the draught of the ship and the state of the tide. The width of the carriages and the number and gauge of the rails should be determined from the beam and displacement of the maximum sized ship. For a two-rail system, the load should be shared equally between the tracks. For a larger installation with more than two rails, the transverse load distribution across the tracks should be calculated by a naval architect or using accepted empirical formulae.

The loads on the dry berths should be provided by the shipyard operator.

The maximum load imposed on the fore end block should be calculated as the point at which the ship is being uphauled but the lower end is still supported by the water. When the ship is in contact over the length of the keel and above water level, the design load distribution should be taken as being the same as in its drydocking condition.

NOTE From the moment of first contact of the ship with the shore end keel blocks of the carriage, load is applied to the rails in proportion to the lost buoyancy of the ship as it is drawn out of the water. At the time of first contact the ship is in floating trim, but as the carriage is uphauled the angle between the ship and the blocks reduces. Just before the keel becomes parallel with the blocks, the maximum load is imposed on the fore end block. This is the point of full sue load.

7.3.2 Shipbuilding berths

7.3.2.1 Components

The design of a shipbuilding berth should comprise the following components:

- inclined berth structure;
- dynamic launching interface between ship and berth;
- ship launch release system;
- ship dynamic launch energy dissipation system.

The launching system and loads applied to the berth structure during both shipbuilding and dynamic launching should be as specified by the ship designer.

7.3.2.2 Dynamic loading during launching

The point loads ascertained by static calculations of launching conditions should be increased by 25% to take account of dynamic forces.

7.3.3 Seismic effects

In locations at risk of seismic activity, the launchways, carriages and supporting structures should be such that a ship will not become unstable on the launchway or carriages, and any part of the supporting structure will not fail leading to the collapse of the ship on the launchway or carriages. For the design of other structures where ships are likely to be located for periods, such as dry berths, these structures should be able to accommodate seismic events without damage to ships through either instability or excessive permanent deflection.

7.4 Equipment in slipways and shipbuilding berths

7.4.1 Slipways

7.4.1.1 Carriages

NOTE Simple slipway carriages are usually constructed of steel with timber keel and bilge blocks, and are of modular form whereby a number of unit lengths can be joined together to suit the length of ship being slipped.

Carriages should be of the rigid, semi-rigid or telescopic types of design, and should be chosen according to the particular operational requirements, taking into account the following factors.

- Rigid cradles are simpler to operate.
- Telescopic carriages are collapsible and result in a shorter length of slipway under water.

The structure of the carriage for a marine railway should be a single unit, since telescoping is not possible. At the seaward end the structure can be of considerable height, and bracing should be provided to maintain stability.

The carriages should be designed so that the keel and bilge block loads can be transferred to the wheels and rails without overstress, with due attention being paid to the heavy point load under the bow during the suing process.

The maximum intensity of the wheel loading allowed on the carriages is a function of the number of wheels, size of wheels, etc. but should be ascertained before the final design of the slipway is undertaken. The maximum wheel load should preferably be restricted to 30 t with an upper limit of 40 t.

The wheel diameter should be the minimum compatible with the overall stability of the carriage, the berthing characteristics, and the chosen rail section.

The rail section should be chosen on the basis of the cradle and track design, the berthing characteristics, the client's preferences, and the availability of materials.

It should be assumed that the full displacement of the ship can ultimately be carried on the keel blocks, but that 25% of the displacement might impinge on each line of the bilge blocks. An out-of-balance factor of 1.33 should be used in determining the loads on the cradle and rails, on the basis that a ship is generally heavier at the stern.

The concentrated point load under the bow during the suing process should be distributed in the design by the use of flexible blocking with rubber sections fixed to the top of the timber keel blocks at the leading carriage(s).

Slipways may be fitted with single or double flanged wheels running on rails of crane or railway section, or with rollers running on a plated track with lipped guides. Sealed roller bearings should be provided to reduce friction, but provision of access for maintenance should be made, since the equipment might be immersed in sea water for prolonged periods.

A corrosion protection system should be provided to the carriages and rails or plates.

As a safety measure, a rack and pawl system, consisting of a rack laid on the slipway base structure and a pawl or series of pawls attached to the slipway carriage at intervals, should be provided.

7.4.1.2 Hauling winches

The winch may be either fully electric or electro-hydraulic, depending upon the make and design to be used. Where two winches are required to work together, they should be synchronous or otherwise controlled in such a way that the speed of the different winches remains equal, in order to try to limit fluctuations of the load for each of the winches during the winching process.

The design of the haulage system should be simple and robust and with adequate capacity to deal with unexpected or deteriorating conditions that can occur during ship repair operations.

In determining the capacity of the winch, an allowance for the cumulative effect of carriage wheel friction, sheave friction and the wire rope stiffness should be included, assuming 2% of wheel load for ball or roller bearings, and 5% of wheel load for plain or bushed bearings.

7.4.1.3 Rope system

The rope system should be designed for the specific geometry and loads expected from the ships to be accommodated.

The rope system should minimize the risk to personal safety posed by rope breakage.

Rollers or low friction blocks should be provided to prevent the rope dragging on the ground and becoming damaged. Where necessary, rope guides should be provided on the sheaves.

The safety factor for wire ropes used in the haulage system should be not less than 3, based on the certified breaking strength of the rope divided by the maximum rope tension. The maximum rope tension should be calculated as the greater of the following two cases:

- rated capacity of the winch;
- maximum force during operations, including but not limited to the forces due to accelerations, sheave frictions and dead loads.

Sheave and winch drum diameters should be not less than those recommended in BS EN 13001 and by the rope manufacturers for the type of rope under consideration. In general, sheave and drum diameters should be not less than 24 times the rope diameter.

7.4.1.4 Control system

The control system should be designed such that when the uphaul winch is operating, the downhaul winch is paying out to ensure the downhaul rope does not become slack or impose additional load on the uphaul winch. When the downhaul winch is operating, the uphaul rope should be similarly controlled. With a multi-part hauling system, the uphaul and downhaul ropes travel at different speeds, and this should be taken into account in the design.

Provision should be made for acceleration and deceleration during the start-up and stopping of the winch.

The operational positions for all automatic changes of speed and automatic stopping should be fully adjustable after installation to suit the actual operational conditions. Control provisions such as limit switches should be provided such that the automatic changes of speed can be implemented.

In the event of an overload condition, the winch should automatically release/pay out the rope in a controlled manner until the excess load in the rope is removed/alleviated, and should then sustain the stalled load. An overload alarm should be initiated.

7.4.1.5 Dry berths

The dry berths at the top of the slipway should be designed in accordance with the recommendations for shiplift dry berths given in Clause **8** for:

- transfer system;
- piped and electrical services.

7.4.2 Shipbuilding berths

The equipment related to shipbuilding berths is principally cranes associated with the shipbuilding process, which should be in accordance with **5.4.3**.

8 Shiplift facilities

8.1 Operational parameters of shiplifts

8.1.1 Shiplift facility reliability

The design of a shiplift facility should take into account the reliance of the shipyard operations on the availability of the shiplift to retrieve and launch ships. A failure of any part of the system to perform correctly could lead to the shipyard being unable to deliver ships to owners after building or repair. The design life and maintenance programme should be specified to maximize the reliability of the shiplift facility with due regard to efficiency of construction.

8.1.2 Nomenclature for shiplift facility components in documentation

To avoid misunderstanding of the scope intended when using the term "shiplift", the term should not be used on its own in documentation throughout the design process.

The principal shiplift facility components should be referred to in all documentation preceded by the word "shiplift", for example:

- shiplift hoist;
- shiplift control system;
- shiplift electrical system;
- shiplift platform;
- shiplift transfer system;
- shiplift pier;
- shiplift transfer area;
- shiplift dry berth.

8.1.3 Shiplift facility capacity

The required capacity of the shiplift facility should be clearly defined in terms of the following parameters:

- platform dimensions (length and width in metres);
- maximum distributed load (tonnes per metre);
- maximum lift capacity (tonnes);
- nominal lifting capacity (displacement in tonnes of the maximum sized typical ship which can be lifted).

These parameters should be determined from the throughput mix of ships for which the shiplift facility is intended.

NOTE The capacity of a shiplift to lift a specific vessel of a specific docking displacement and load distribution is independent of the form of articulation of the platform.

8.1.4 Platform dimensions

The platform length should be taken as the distance between the extremities of the cantilevers at each end of the platform. The platform width should be taken as the usable deck width excluding the clearances between the deck and the hoist support structures.

8.1.5 Ship maximum length

The length of the platform should be designed for the maximum length of ship to be accommodated, taking into account the loading imposed by the stern and bow areas of the ship and the potential for overhanging the ends of the platform.

NOTE For side transfer only shiplifts, there is usually no physical restriction on the extent of overhang. For end transfer, the landward end fixed structure is a physical constraint.

8.1.6 Ship maximum width

The design of the facility should be able to accommodate the maximum width of ship to be safely manoeuvred into position between the shiplift piers which support the hoists.

The design should include sufficient space for rope handling and equipment to haul in and then maintain the ship in the correct position over the submerged platform.

8.1.7 Docking depth

The docking depth provided should be taken as the depth of water at MHWN over the centre line of the transfer carriage or cradle blocks when the platform is at its lowest level.

The docking depth should include a suitable allowance for under keel clearance over the carriage or cradle blocks. The design clearance should be at least 0.5 m.

8.1.8 Maximum distributed load (MDL)

The maximum distributed load (MDL) should be used as the principal measure of the lift capacity of a shiplift.

The MDL should be expressed in tonnes per metre length of platform which the platform is designed to lift. It should be calculated as the capacity in tonnes of one pair of hoists minus the weight of the length of platform associated with this pair of hoists, divided by the hoist spacing in metres.

The design concept should include the potential for adopting a dual MDL, where part of the length of the platform accommodates the highest expected intensity of loading imposed by a ship and the remaining length accommodates a lower value of MDL.

NOTE Where transfer from the platform is at the end, the higher MDL is nearer the land.

8.1.9 Maximum lifting capacity

The maximum lifting capacity should be calculated as the sum of:

a) maximum value of MDL multiplied by the effective length of the platform for which it is designed; and, where applicable;

b) lower value of MDL multiplied by the effective length of the platform for which it is designed.

The effective platform length should be calculated to include the length of each end cantilever, which should be not greater than 0.4 times the adjacent hoist spacing.

8.1.10 Nominal lifting capacity

NOTE The nominal lifting capacity takes account of the realistic applied load distribution from a typical ship in conjunction with the platform response to a varying distributed load. Hence the nominal lifting capacity represents the maximum displacement in tonnes of a typical ship which can be lifted without exceeding the MDL.

The nominal lifting capacity should be calculated as the maximum lifting capacity multiplied by the distribution factor.

The distribution factor includes an allowance for dynamic effects and is intended to limit the load applied to the platform such that the MDL of the platform is not exceeded. It should be taken as:

- 0.67 for articulated platforms which do not distribute load longitudinally between adjacent hoists through longitudinal structural bending continuity; or

- a higher value where it can be justified by calculation for the following instances:
  - articulated platforms in combination with either longitudinal load-spreading cradles, such as those incorporating hydraulically linked systems, or arrangements where the hoist spacing is an integer multiple of the cradle spacing; or
  - rigid platforms in combination with either simple or load-spreading cradles.

Under all circumstances the value of the distribution factor should be not more than 0.83.

8.1.11 Use of platform for ship repair

The repair of a ship whilst drydocked on the platform should be only an emergency design case and not part of normal planned operations, unless the platform is specifically designed as a repair berth.

NOTE The reasons for this include the following.

- *The platform decking is typically of lightweight construction and generally not designed as a working area.*
- *Waste material tends to fall or be washed down into the shiplift platform dredged pit, increasing subsequent maintenance and increasing seawater contamination.*
- *Other ships are prevented from being retrieved or launched by the facility.*

8.1.12 Anchorages and afloat berths

Provision should be made in the design for ships which are waiting to access the shiplift facility and others which have been re-launched prior to redelivery.

NOTE Where the shiplift piers protrude from the waterfront, they can serve as afloat waiting berths if they are designed appropriately. Access to the afloat berths can also function as the access route for small land-based cranes to maintain the hoists.

8.1.13 Shiplift transfer area with rails

The provision of a transfer area should be made for the movement of ships from platform to dry berth or vice versa.

The transfer area size and level should be determined according to the type of transfer system adopted, of which the options are:

- a two-level transfer system, which incorporates a dedicated transfer carriage mounted on rails within a transfer pit below the platform and dry berth level;
- a single level transfer system, which has all the rails at the same level and carriages which are capable of changing the direction of transfer, generally rotating the wheels through 90° on plan.

In selecting the transfer system, the designer should take into account the respective merits of each system, which are principally:

- a two-level system typically has shorter overall transfer time particularly for smaller ships;
- a single level system obviates the need for a large operationally sterile transfer pit area.

8.2 Siting of shiplifts

8.2.1 Topography

The shiplift facility usually incorporates a level rail system over an extensive area, thus facilities should be sited where there is a large area of flat land available, either natural or formed.

8.2.2 Location and orientation

Most shiplift facilities incorporate transfer systems which restrict ship movement to a rectilinear routing with all rails either parallel or at 90 degrees to the platform centre line. When determining the location and orientation of shiplift facilities, the following factors should be optimized:

- good marine access water depth;
- tranquil wave climate;
- low velocity currents and tidal streams;
- platform centre line parallel with prevailing wind;
- good onshore access to dry berths and working space;
- proximity to onshore workshops;
- elapsed time to transfer a ship from platform to dry berth.

8.2.3 Dry berths and transfer layout

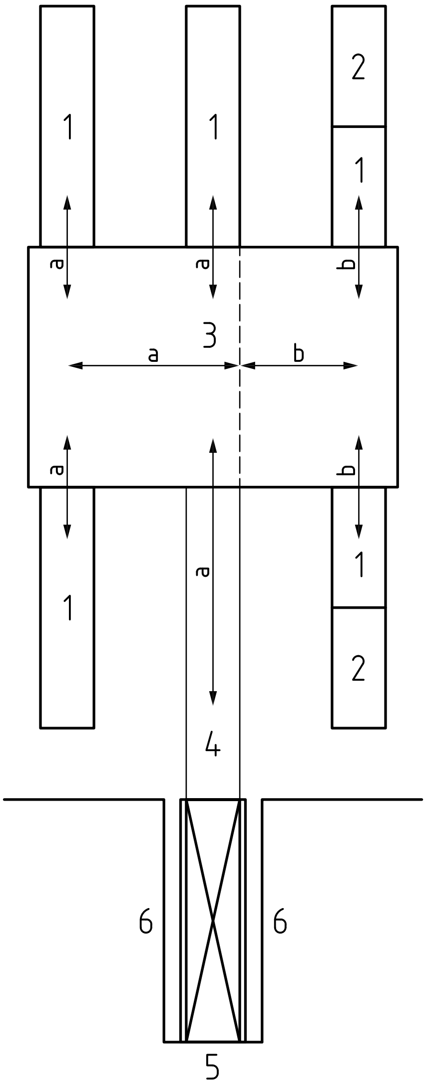
The layout of the transfer area should be designed to minimize the area which will be subjected to the MDL as the ship is transferred from the platform to the dry berth. The design throughput mix of ships determines the number, size and load capacity of the dry berths. Dry berths should be classified as either:

- primary berths with direct access to the platform via a transfer area; or
- secondary berths for longer term repair or building purposes which have a primary berth between them and the transfer area.

The design should optimize the need for the full MDL capacity dry berths and lower capacity dry berths. The design of the whole transfer area and dry berths for the full MDL, particularly for larger load capacity shiplift facilities, should be avoided. The optimization assessment of the transfer arrangement should include a suitable transfer arrangement, of which the principal types are:

- end transfer only to side transfer area with capacity to support full MDL to either:
  - all dry berths; or
  - some dry berths with lower load transfer capacity to other berths (see Figure 13);
- mixed arrangement comprising end transfer to dry berths with capacity to support full MDL and side transfer to dry berths designed to support a lower value of distributed load (see Figure 14);
- side transfer only to side transfer area with capacity to support full MDL to either:
  - all dry berths; or
  - some dry berths with lower load transfer capacity to other berths (see Figure 15).

Figure 13 **Typical end transfer only arrangement** *(1 of 2)*



Key

1 Primary berth
2 Secondary berth
3 Transfer area
4 End transfer
5 Shiplift platform
6 Shiplift pier
a Full MDL
b Reduced MDL

a) Plan of shiplift platform