1.1 Application

(a) Dredgers designed to operate wholly or generally for the purpose of raising spoil such as mud, silt, gravel, clay, sand or similar substances, general rubbish or ore, minerals, etc., for the bed of the sea, rivers, lakes, canals or harbours, etc. The dredged material may be placed in suitably designed holds or similar spaces within the ship.

(b) Hopper dredgers, designed to raise spoil, as described in (a), and so arranged that the dredged material may be placed in one or more hoppers within the ship. For the purpose of this definition, a hopper is a hold or other space designed to carry dredged spoil and also arranged to enable such spoil to be discharged through doors or valves in the bottom of the ship. Spaces arranged to be unloaded by means of conveyor belts, suction pipes or similar gear are not to be regarded as hoppers unless adequate bottom doors or valves are also fitted.

(c) Split hopper dredgers, which are designed similarly to that described in (b) but arranged such that the spoil is discharged through the bottom of the ship by means of the split hull being separated using hinges and actuating devices.

(d) Reclamation craft, reclamation ships, etc., which work in a manner similar to dredgers but draw their spoil from dredging craft and discharge it ashore.

(e) Hopper barges designed to carry spoil or dredged material in hoppers within the ship. For the definition of a hopper, see 1.1.1(b).

(f) Split hopper barges, which are designed similarly to that described in (e) but arranged such that the spoil is discharged through the bottom of the ship by means of the split hull being separated using hinges and actuating devices.

1.1.2 The scantlings and arrangements are to be as required by Chapter 1, except as otherwise specified in this Chapter.

1.1.3 Where bottom dump doors or valves are fitted, hatch covers are not required. Proposals for the omission of hatch covers where bottom dump doors or valves are not fitted will be specially considered.

1.1.4 Ships which have their machinery placed on a shallow raft, rather than within a hull, will have their scantlings specially considered. Dredgers which resemble drilling rigs, or similar offshore structures, in their design or mode of operation will be considered under the Rules for such structures.

1.1.5 Ships of unusual form or proportions, or intended for unusual dredging methods, will receive individual consideration on the basis of the general standards of the Rules.

1.1.6 The requirements provide for transverse and longitudinal framing of the structure. In general, the midship region scantlings are to extend over the full length of hoppers and holds. The extent is to be not less than 0.4L amidships, and may need to be increased if the design and loading conditions of a particular ship result in its maximum bending moment occurring other than at amidships.

1.2 Stability

1.2.1 Attention is drawn to the thixotropic properties of certain types of dredged material which, as a result of the ship’s motions, can cause the spoil to shift within spoil spaces, resulting in undesirable changes in trim or angles of heel. This can be particularly dangerous in ships with closed top spaces.
13 Class notations

13.1 In general, ships complying with the requirements of this Chapter will be eligible for one of the following classes:
(a) **100A1 dredger**. This class will be assigned to ships as defined in 1.1.1(a).
(b) **100A1 hopper dredger**. This class will be assigned to ships as defined in 1.1.1(b).
(c) **100A1 split hopper dredger**. This class will be assigned to ships as defined in 1.1.1(c).
(d) **100A1 reclamation craft**. This class will be assigned to ships as defined in 1.1.1(d).
(e) **100A1 hopper barge**. This class will be assigned to ships as defined in 1.1.1(e).
(f) **100A1 split hopper barge**. This class will be assigned to ships as defined in 1.1.1(f).

13.2 The class notations will be assigned to ships based on the following:
(a) The class notations in 1.3.1 will be assigned to ships which are intended to make unrestricted sea-going voyages, either as part of their work or while transferring from one work area to another as part of their normal operations and have also been designed to perform dredging operations in defined dredging service areas.
(b) Where dredger types listed in 1.3.1(a), 1.3.1(b) and 1.3.1(c) perform dredging operations at reduced freeboards, resulting in a dredging draught \( T_m \) greater than the summer draught and without a dredging service area restriction, the class notation will be extended as follows: ‘dredging draught \( T_m \) of … metres in sea states with \( H_s < \ldots \) metres’ and will be subject to special requirements of National Authorities, see 1.6.1 to 1.6.3.
(c) Where dredger types listed in 1.3.1(a), 1.3.1(b) and 1.3.1(c) perform dredging operations at reduced freeboards, resulting in a dredging draught \( T_m \) greater than the summer draught but with a dredging service area limited to within 21 nautical miles from shore, the class notation will be extended as follows: ‘dredging within 21 miles from shore at a dredging draught \( T_m \) of … metres’ and will be subject to special requirements of National Authorities, see 1.6.1 and 1.6.2.
(d) Where requested, the assignment of more than one dredging draught may be considered, i.e., ‘dredging at draught \( T_{m1} \) …’ and ‘dredging at draught \( T_{m2} \) …’, etc., provided agreement is obtained from the National Authorities and the applicable requirements of this Chapter are complied with.

13.3 Ships intended to be operated only in suitable areas or conditions which have been agreed by the Committee, as defined in Pt 1, Ch 2.2.3.6, 2.3.7, 2.3.8 and 2.3.10, will receive individual consideration on the basis of the Rules with respect to the environmental conditions agreed for the design basis and approval. In particular, dredgers complying with the requirements of this Chapter, and Pt 3, Ch 13.7 for the reduced equipment requirements, will be eligible to be classed:
- **A1 dredger protected waters service**, see Pt 1, Ch 2.2.3.6, or
- **100A1 dredger with service restriction notation**, whichever is applicable. Hopper dredgers, split hopper dredgers, reclamation craft, hopper barges and split hopper barges would be considered similarly.

13.4 Where a ship complying with the requirements of this Chapter has the bottom structure additionally strengthened for operating aground in accordance with Section 7, it will be eligible for the special feature notation ‘bottom strengthened for operating aground’.

13.5 In addition to the above notations, an appropriate descriptive note may be entered in the Register Book indicating the type of dredging or reclamation craft (see Pt 1, Ch 2.2.6.1), e.g., ‘trailing suction dredger’, ‘cutter suction dredger’, ‘bucket dredger’, ‘grab dredger’, ‘dipper dredger’, ‘self-discharging sand dredger’, etc.

13.6 The Regulations for classification and assignment of class notations are given in Pt 1, Ch 2 to which reference should be made.

14 Information required

14.1 In addition to the information and plans required by Pt 3, Ch 1.5 details of the following are to be submitted:
- Sections through hoppers, wells, pump-rooms and dredging machinery spaces.
- Hopper, hold and well bulkheads and associated weirs.
- Scarfing arrangements at hopper, hold and well ends.
- Hinges, actuating and locking arrangements, together with supporting structure, weld connection details and calculations of design forces for split hull separation devices.
- Deckhouse and deckhouse support structure.
- Outline arrangement and main scantlings of ‘A’ frames, gantries, positioning spuds, hopper doors and similar items, the strength and integrity of which directly affect the hull structure of the vessel. Support structure in way of ‘A’ frames, positioning spuds and other dredging structures. Seats of dredging machinery and pumps. If dredging equipment is stored during voyages, plans of any special arrangements for dismantling, storage and reassembly. Sufficient particulars of static and dynamic loading for these items are to accompany the details to enable verification of the strength and effectiveness of the supporting ship structure.
- A full set of stability data which is to be placed on board the ship, see Pt 1, Ch 2.3.
- Calculations of hull girder still water bending moment and shear force where applicable, see 2.1.1, for the proposed loading conditions, including densities of spoil. When the still water bending moment and block coefficient are being calculated, any water within spoil spaces should be regarded as added weight, whilst that in dredging ladder wells and spud wells should be regarded as lost buoyancy.

1.5 Symbols

15.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:
- \( B \) = breadth, in metres, defined as the greatest moulded breadth excluding any localised bulge on the hull associated with the attachment or handling of the dredging gear.
1.6 Requirements for dredgers operating at reduced freeboards

1.6.1 Requirements of IMO DR 68 Guidelines for the Operation of Dredgers at Reduced Freeboards are to be complied with.

1.6.2 The dredger is to be of a self discharging type and equipped with bottom valves. When the ship is operating at a reduced freeboard, i.e., \( \frac{1}{2} \) or \( \frac{1}{3} \) of its summer freeboard, the capacity of these bottom valves, or a part thereof, is to be sufficient to obtain the summer freeboard by discharging the appropriate amount of cargo within 8 minutes (IMO DR 68 refers).

1.6.3 Where the class notation ‘dredging draft \( T_m \) of … metres in sea states with \( H_s < \ldots \) metres’ is assigned, the Master is to be provided with suitable information on the actual situation of the sea conditions and the forecast in terms of significant wave heights.

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Section 2

Longitudinal strength

2.1 General

2.1.1 Longitudinal strength calculations are to be made in accordance with the relevant requirements given in Pt 3, Ch 4, except as indicated in this Section.

2.2 Loading conditions

2.2.1 Details are to be submitted of the following loading conditions for examination of longitudinal strength:

(a) Homogeneous load conditions (including details of densities of spoil) for both departure and arrival at draught, \( T \), and maximum dredging draught, \( T_m \), where this exceeds \( T \), see also 15.1.4.

(b) Part loaded conditions (including details of densities of spoil) and ballast conditions for both departure and arrival.

(c) Any specified non-homogeneous load conditions.

2.2.2 If any dredging equipment has to be unshipped, lowered or otherwise specially arranged or stowed before the ship proceeds on a sea-going voyage, this fact is to be indicated on the longitudinal strength information required to be submitted and is also to be clearly stated in the final Loading Manual supplied to the ship.

2.2.3 For loading conditions, and any other preparations required to permit ships with a notation specifying some service limitation to undertake a sea-going voyage, either from port or building to service area or from one service area to another, see Pt 1, Ch 2.1.
2.2.4 Where a ship is arranged with two spoil spaces account is to be taken in the calculation of the still water bending moment of either one of these spaces being empty, unless such loading is specifically precluded in the Loading Manual supplied to the ship.

2.2.5 The requirements of Pt 3, Ch 4.8.3 regarding loading instruments are not applicable to dredging and reclamation craft.

2.3 Hull bending strength

2.3.1 Hull bending strength standards are to comply with the relevant requirements of Pt 3, Ch 4, taking account of the contents of 2.4 and 2.5.

2.3.2 For split hopper dredgers or barges, due account is to be taken of the lateral forces and moments on each half hull which are exerted by the pressure of the spoil and dynamic wave loading, see 17.2.

2.4 Design vertical wave bending moments

2.4.1 The design vertical wave bending moment at amidships, $M_{w}$, is to be determined from Pt 3, Ch 4,5.2 with the ship service factor, $f_1$, given in Table 12.2.1.

$$M_{wd} = f_{wd} f_2 M_{wo}$$

where

$M_{wo}$ is determined from Pt 3, Ch 4,5.2, using $C_{bm}$ in place of $C_b$

$f_2$ is given in Pt 3, Ch 4.5.2

$f_1$ and $f_{wd}$ are defined in Table 12.2.1.

2.5 Permissible still water bending moment for dredging conditions

2.5.1 The maximum permissible still water bending moment, $M_{sm}$, for dredging conditions where draught $T_m$ exceeds $T$ is not to exceed:

$$|M_{sm}| = |M_s + f_1 f_2 M_{wo} - M_{wd}| \text{ kN m (tonne-f m)}$$

where $M_{wd}$ is defined in 2.4.2.

Where applicable, the relevant loading conditions are to be included in the final Loading Manual, see 15.1.4 and Pt 3, Ch 4.8.1.

2.6 Calculation of hull section modulus

2.6.1 The hull midship section modulus is to be calculated in accordance with the requirements of Pt 3, Ch 3,3.4 taking account of 2.6.2 and 2.6.3. See also 17.1 for split hull arrangements.

2.6.2 Centreline box keels within the hopper spaces may normally be regarded as 100 per cent effective provided that they are effectively scarfed to the vertical keels or equivalent structure at each end of the hopper spaces.

2.6.3 Where a long superstructure or deckhouse is fitted extending within the midship region, the requirements for longitudinal strength in the hull and erection will be specially considered.

2.7 Hull shear strength

2.7.1 Special attention is to be paid to the actual shear forces at the spoil space end bulkheads. The inclusion of the effective thickness of longitudinal bulkheads, centre box keel plating and other longitudinal material at these positions, will be considered in relation to the arrangement of structure proposed.

2.7.2 For ships classed A1 protected waters service, see 4.6.1.

2.7.2 The vertical wave shear forces, $Q_w$, are to be calculated in accordance with Pt 3, Ch 4.6. In dredging conditions, where the dredging draught $T_m$ is greater than $T$, $K_2$ may be taken as $f_{wd}$.
Section 3
Deck structure

3.1 Deck plating

3.1.1 Dredgers, hopper dredgers and hopper barges classed for unrestricted service are to have the minimum thicknesses required by Ch 1,4 increased by 2 mm for those areas of the strength deck outside line of openings which are exposed to the weather.

3.1.2 Ships classed 100A1 extended protected waters service are to have the minimum thicknesses required by Ch 1,4 for all strength deck plating outside line of openings. The minimum value of s, used in the formulae, may be taken as 550 mm.

3.1.3 Ships classed A1 protected waters service may have the minimum thicknesses as given in Ch 1,4 for all strength deck plating outside line of openings. The midship region, and for 0,075L from the ends, is to have a thickness not less than:

\[ t = 0.01s \text{ mm} \]

3.1.5 The deck plating thickness and supporting structure may be required to be reinforced in those areas of deck which are liable to be subjected to regular, heavy, impact loads such as could occur when maintaining or inspecting large items of dredging gear, etc. It is recommended that consideration be given to increasing the plating thickness in these areas to:

\[ t = 0.02s \text{ mm} \]

with a minimum

\[ t = 10 \text{ mm} \]

3.2 Deck stiffening

3.2.1 The scantlings of deck beams or longitudinal are to comply with the requirements of Ch 1,4.3.

3.3 Deck supporting structure

3.3.1 The scantlings of the deck supporting structure are to comply with the requirements of Ch 1,4.4.

Section 4
Shell envelope plating

4.1 Keel

4.1.1 On ships over 50 m in length, where there is a centreline well, or where hopper doors are fitted on the ship’s centreline, i.e., where no centreline box keel is fitted in a hopper, a keel strake is to be fitted on each side of the well or hopper door opening, dependent upon the proposed docking arrangements for the ship. The width of each keel strake is to be not less than half that required for a centreline keel nor less than 400 mm. The thickness of each keel strake is to be not less than the thickness required for a centreline keel in Ch 1,5.2.

4.2 Bottom shell

4.2.1 The minimum thickness of bottom shell plating amidships on hopper dredgers and hopper barges classed for unrestricted service is to be 15 per cent greater than that required by Ch 1,5.3. The thickness of bottom shell plating on ships classed A1 protected waters service is to be not less than:

\[ t = (5sL \sqrt{D} \times 10^{-5} + 5) \text{ mm} \]

or that required for Ch 1,5.3, whichever is the lesser, but with an overall minimum thickness of 6 mm.

4.2.2 Where hoppers extend outside 0.4L amidships, the thicknesses required for the bottom shell amidships are to be maintained for at least two frame spaces beyond the ends of the hoppers before being tapered to the end thicknesses.

4.3 Operating aground

4.3.1 For ships intended to operate aground, see Section 7.

4.4 Bottom openings

4.4.1 The corners of hopper door openings and of bucket and ladder wells are generally to be parabolic or elliptical on all ships where L is greater than 50 m, and should generally be rounded on smaller ships. On ships where L is greater than 90 m, the arrangement of hopper and well corners within 0.5L amidships should generally be as required for deck hatch corners. The sealing arrangements for hopper doors may lie within the line of the corners, provided that the construction is such as to avoid high stress concentrations in the structure.
4.5 Ships with chines

4.5.1 On ships arranged with two chines each side, the bilge plating should generally be calculated from the bottom plating formulae. On hard chine ships, flanged chines will not generally be approved, but where a chine is formed by knuckling the shell plating, the radius of curvature, measured on the inside of the plate, is to be not less than 10 times the plate thickness. Where a solid round chine bar is fitted, the bar diameter is to be not less than 50 mm or three times the thickness of the thickest abutting plate, whichever is the greater. Where welded chines are used, the welding is to be built up as necessary to ensure that the shell plating thickness is maintained across the weld.

4.6 Side shell

4.6.1 The thickness of the side shell is to be in accordance with Ch 1,5.4. On ships classed A1 protected waters service the thickness of the side shell throughout, including at ends, may be reduced by 20 per cent from that required by Ch 1,5.4 and Pt 3, Ch 5 and Pt 3, Ch 6 as appropriate, provided that the combined shear stress does not exceed 110 N/mm² (11.2 kgf/mm²).

4.6.2 Where high compressive loads occur in the sheer-strake, the thickness may be required to be increased to minimise the likelihood of buckling.

4.7 Swim ends

4.7.1 The plating of swim ends is to have a thickness not less than that required for the bottom shell up to the waterline at draught $T$, see also Table 12.7.1. It is to have a thickness not less than that required for side shell in the areas more than 1.0 m above the waterline at draught $T_m$. In intermediate areas the thickness may be tapered from the bottom to the side shell requirements.

Section 5
Shell envelope framing

5.1 Longitudinal stiffening

5.1.1 The scantlings of bottom and side shell longitudinals are to comply with the requirements given in Table 12.5.1.

5.1.2 For ships intended to operate aground, see Section 7.

5.2 Transverse stiffening

5.2.1 For bottom structure with transverse framing, see Section 6.

5.2.2 For ships intended to operate aground, see Section 7.

Table 12.5.1 Longitudinal stiffening

<table>
<thead>
<tr>
<th>Position of longitudinals</th>
<th>Modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Bottom</td>
<td>$Z = \frac{l_e^2 s H k_c}{K_1}$ cm³</td>
</tr>
<tr>
<td></td>
<td>where $l_e$ = effective span of longitudinals, in metres, and is to be taken as not less than 1.85 m except as provided for in 6.3.1</td>
</tr>
<tr>
<td></td>
<td>$K_1$ = 120 on ships classed 100A1 or 100A1 extended protected waters service</td>
</tr>
<tr>
<td></td>
<td>$K_1$ = 150 on ships classed A1 protected waters service</td>
</tr>
<tr>
<td></td>
<td>$c$ = a factor varying from 1.0 at $\frac{D}{2}$ to $\frac{2060}{3620 – 1560/F_B}$ at bottom, intermediate values by interpolation. For ships with hogging still water bending moments in loaded conditions and for split hull vessels, $c = 1.0$ as defined in Pt 3, Ch 4,5.1</td>
</tr>
<tr>
<td></td>
<td>$F_B$ = as defined in Pt 3, Ch 4,5.1</td>
</tr>
<tr>
<td></td>
<td>$K_1$ = 120 on ships classed 100A1 or 100A1 extended protected waters service</td>
</tr>
<tr>
<td></td>
<td>$K_1$ = 150 on ships classed A1 protected waters service</td>
</tr>
<tr>
<td></td>
<td>$k$ = higher tensile steel factor, see Pt 3, Ch 2.1</td>
</tr>
</tbody>
</table>

(2) Side shell

(a) For ships classed 100A1 or 100A1 extended protected waters service

The minimum modulus of side longitudinals is to be in accordance with Ch 1,6.2

(b) For ships classed A1 protected waters service

The modulus required by (a) and reduced by 5 per cent

(3) Bilge

The scantlings of bilge longitudinals are to be graduated between those required for the bottom longitudinals and the lowest side longitudinals

5.2.3 The scantlings of side frames amidships are to be in accordance with Ch 1,6 for ships classed for unrestricted service or 100A1 extended protected waters service. The modulus of side frames may be reduced by eight per cent for ships classed A1 protected waters service.

5.3 Primary supporting structure at sides

5.3.1 The spacing of transverses supporting side longitudinals is generally to be in accordance with Ch 1,6.4, but is not to exceed 4.0 m.

5.3.2 Transverses supporting side longitudinals are to comply with the requirements of Ch 1,6.4, except for ships classed with a service restriction notation and all ships classed A1 protected waters service, where the requirements are given in Table 12.5.2.
Table 12.5.2 Primary supporting structure at sides

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Item</th>
<th>Requirement</th>
</tr>
</thead>
</table>
| h = vertical distance from mid-point of span to deck at side, in metres | Transverses supporting side longitudinals amidships | All ships classed 100A1 extended protected waters service:  
\[ Z = 9.5S h l_e^2 \text{ cm}^3 \]  
All ships classed A1 protected waters service:  
\[ Z = 9.0S h l_e^2 \text{ cm}^3 \]  |
| \( l_e \) = effective length of supporting member, in metres |  |
| I = moment of inertia of supporting member, in cm\(^4\), see Pt 3, Ch 3.3 |  |
| S = spacing, or mean spacing, of supporting member, in metres | Transverses and web frames supporting side longitudinals abreast of spoil spaces | Inertia of not less than:  
\[ I = 2.5l_e Z \text{ cm}^4 \]  |
| Z = section modulus of supporting member, in cm\(^3\), see Pt 3, Ch 3.3 |  |

5.3.3 In way of transverse framing, web frames may be required in way of hopper cross members. Alternative arrangements may be submitted for consideration.

5.3.4 The end connections of side transverses and web frames to deck and bottom transverses abreast of spoil spaces are to be arranged to prevent shear buckling of the members' webs.

5.3.5 For wash bulkheads fitted in lieu of web frames abreast spoil spaces, see 8.3.6.

6.2.2 The spacing of intercostals and longitudinal side girders is to be such as to ensure continuity of strength at bulkheads, ends of spoil spaces and wells and at ends of machinery seats so far as practicable, see also Ch 1,7. An intercostal is to be fitted in the buoyancy space abreast hopper openings when the distance between the hopper opening and the ship's side exceeds 4.0 m.

6.2.3 Abreast of dredging wells and spoil spaces the minimum depth of floor at its inboard end is to be not less than:
\[ d_w = 20 (B + l_e + 2T_m) \text{ mm} \]
The thickness of the web and area of the face plate are to be as required by Ch 1,7.2.

6.3 Single bottoms longitudinally framed

6.3.1 The spacing of transverses is to be in accordance with 5.3.1, and are to be supplemented by the following arrangements of brackets:

(a) On the ship's centreline, or on each side of dredging wells where there is no structure on the centreline, the brackets are to be spaced not more than 1.25 m apart and are to extend outboard to the first longitudinal, port and starboard. The longitudinals supported by the brackets may be calculated using a nominal transverse spacing of 1.6 m.

(b) On ships where the sides are transversely framed, the brackets are to be fitted at every frame and are to extend inboard to the first longitudinal on the flat of bottom. This longitudinal is to be based on a span equal to the spacing of the transverses.

(c) The thickness of these intermediate brackets is to be not less than:
\[ t = (0.25B + 1.85 \sqrt{T_m}) \text{ mm}. \]

6.3.2 In areas of high shear loading, the thickness and stiffening of the web plates on transverses, etc., may have to be increased. The depth of transverses is to be not less than 2.5 times the depth of the slot for the bottom longitudinals, and thickness of the web plates is to be not less than 8 mm.

6.3.3 Bottom transverses in spoil space side buoyancy tanks in way of cross-ties are to have a depth, \( d \), of not less than:
\[ d = 28B + 205 \sqrt{T_m} \text{ mm} \]
Their arrangement, scantlings and end connections are to be such as to provide proper continuity of strength across the ship. The transverses are to be fitted with stiffeners in way of every shell longitudinal. The stiffeners should, in general, be equivalent to flat bars with a depth one-eighth of the transverse at that point and a thickness not less than the thickness of the transverse.
6.4 Double bottom – General

6.4.1 Self-propelled dredgers and reclamation ships of more than 500 tons gross and intended for International voyages are to be provided with a double bottom extending from the collision bulkhead to the after peak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

6.4.2 A double bottom need not be fitted in way of watertight compartments used exclusively for the carriage of liquids provided the safety of the ship, in the event of bottom damage, is not thereby impaired.

6.4.3 The double bottom may, however, be interrupted locally, or fitted with wells in way of dredging pumps and other equipment. Where such openings are large, their scantlings and arrangements will be specially considered.

6.4.4 The scantlings are to be in accordance with Ch 1,8 except for the following:
(a) The Rule thickness of centre girders may be reduced by 2.0 mm on ships classed A1 protected waters service.
(b) The Rule thickness of side girders may be reduced by 1.0 mm on ships classed 100A1 extended protected waters service.
(c) The scantlings of floors, longitudinals and plating supporting the bottom of spaces intended to carry spoil are to be determined in accordance with Section 8.

6.5 Double bottom with transverse framing

6.5.1 Plate floors may be fitted at every frame or may be spaced not more than 3.0 m apart with the shell and inner bottom plating between these floors supported by bracket floors. However, plate floors are to be fitted at every frame in the following areas:
(a) As required for Ch 1,8.5.
(b) Below spaces from which dredged material will be discharged by grabs.
(c) In main propulsion and dredging machinery rooms and in peak tanks.
(d) For three frame spaces at ends of spoil spaces and dredging wells.

6.6 Double bottom with longitudinal framing

6.6.1 In locations other than below spaces intended for dredged spoil the section modulus of inner bottom longitudinals is to be not less than:

\[
Z = \frac{l_e^2 s H k c}{K_1} \text{ cm}^3
\]

where
\(l_e\) = effective span of longitudinals, in metres, and is to be taken as not less than 1.85 m
\(s\) = spacing of longitudinals, in mm
\(H\) = height, in metres, from the tank top to the deck at side, (but need not exceed \(T_m\) on ships classed A1 protected waters service)

\(c\) as defined in Table 12.5.1

\(K_1 = 120\) in machinery spaces on ships classed 100A1
\(K_1 = 150\) otherwise
\(k = \) higher tensile steel factor, see Pt 3, Ch 2.1.

6.6.2 The section modulus of longitudinals below spaces intended for dredged spoil is to comply with the requirements of 8.3.7.

6.6.3 The spacing of transverses is generally to be as for dry cargo ships but is not to exceed 4.0 m. Below main dredging machinery the transverses are generally to be spaced not more than 1.0 m apart.

6.6.4 The ends of longitudinal girders under dredging machinery are to be tapered off or efficiently scarfed into other longitudinal structural items.

7 Section 7

Bottom strengthening for operating aground

7.1 Application

7.1.1 The scantlings of bottom structure are to comply with the requirements given in Table 12.7.1.

7.1.2 Unless otherwise specified by the Owner, it should be assumed that non-self-propelled dredging and reclamation craft are to operate aground.
Table 12.7.1  Bottom strengthening for operating aground

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Bottom shell, keel and swim end plating</td>
<td>Thickness to be increased by 20% over the minimum requirements of Ch 1.5, with a minimum of 8 mm</td>
</tr>
<tr>
<td>(2) Bottom longitudinals</td>
<td>Scantlings as required by Table 12.5.1(1) taking ( K_1 = 74 ) and ( c = 1.0 )</td>
</tr>
<tr>
<td>(3) Bilge longitudinals (where fitted)</td>
<td>Scantlings to be the same as bottom longitudinals</td>
</tr>
</tbody>
</table>

(4) Primary stiffening in way of single bottoms, see Notes 1 and 2

(a) Floors to be fitted at every frame with vertical stiffeners spaced, in general, not more than 1.25 m apart
(b) Side girders to be spaced not more than 2.2 m apart and intermediate 100 mm x 10 mm bulb plate longitudinals, or equivalent, fitted

(5) Primary stiffening in way of double bottoms, see Notes 1 and 2

(a) Plate floors are to be fitted at every frame with vertical stiffeners spaced, in general, not more than 1.25 m apart
(b) Side girders to be spaced not more than 2.5 m apart and intermediate 100 mm x 10 mm bulb plate longitudinals, or equivalent, fitted
(c) Where the span of floors between a hopper space and the ship’s side exceeds 3.75 m, a longitudinal girder is to be fitted

NOTES
1. The scantlings of floors, girders and transverses are to be determined in accordance with the requirements of Section 6.
2. The number and size of holes in floors, girder and transverses are to be kept to a minimum, see Ch 1.8.

Table 12.8.1  Effective specific gravity

<table>
<thead>
<tr>
<th>Effective specific gravity less than or equal to 1.4</th>
<th>Effective specific gravity greater than 1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rho \leq 1.4 )</td>
<td>( \rho &gt; 1.4 )</td>
</tr>
<tr>
<td>for vertical boundaries</td>
<td>for boundaries which have an angle, ( \alpha ), with the horizontal plane</td>
</tr>
<tr>
<td>( \rho_{ef} = \rho )</td>
<td>( \rho_{ef} = 1.4 ) = ( 1.4 + (\rho - 1.4)(\cos \alpha)^2 )</td>
</tr>
</tbody>
</table>

8.1 Symbols and definitions

The symbols used in this Section are defined as follows:

\[ \rho_{ef} \] = effective specific gravity to be taken, as defined in Table 12.8.1
\[ h \] = load head, in metres, measured vertically as follows:

(a) For plating, the distance from a point one-third of the height of the plate above its lower edge to the sill of the uppermost overflow weir.
(b) For stiffeners or girders, the distance from the middle of the effective length to the sill of the uppermost overflow weir.

\[ l_e \] = effective length of stiffening members, in metres, see Pt 3, Ch 3.3
\[ s \] = spacing of stiffeners, in mm
\[ t \] = plate thickness, in mm
\[ A_1 \] = cross-sectional area of flange or stiffener, in cm², including coaming plating.

8.1.2 Other symbols are defined in 1.5.1.

8.2 General

8.2.1 This Section provides for:
(a) horizontally and vertically stiffened boundary bulkheads to hoppers, and holds intended for dredged spoil, to ladder wells and to spud wells,
(b) protection against flooding in the event of the ladder well or adjacent bottom plating being damaged by objects dredged up by bucket dredgers, and
(c) continuity of transverse strength in spoil spaces and wing tanks abreast of spoil spaces.
8.2.2 As an alternative to the requirements of this Section regarding primary structure, scantlings may be derived on the basis of direct calculation methods, see Section 18.

8.2.3 Continuity of strength. Arrangements are to be made to ensure continuity of strength at the ends of longitudinal and well side bulkheads. In general, the design should be such that the bulkheads are connected to bottom and deck girders by means of large, suitably shaped brackets arranged to give a good stress flow at their junctions with both the girders and the bulkheads.

8.2.4 Ladder well cofferdams. Ladder wells of trailing suction dredgers are to be isolated from the remainder of the dredger's structure by local cofferdams at least 600 mm wide, or are to be otherwise protected to prevent serious flooding due to the well side plating being breached by the ladder structure should this be damaged in service. Ladder wells of bucket dredgers are to be isolated by cofferdams, the extent and widths of which are to be sufficient to contain any damage to the well side bulkheads or bottom shell plating that could result from the impact of large objects brought up in the dredge buckets. In way of the buckets the cofferdam may be extended outboard in the form of a local watertight double bottom.

8.3 Spoil space and well boundaries

8.3.1 The plating thickness of spoil space boundaries is to be not less than the following:

\[ t = 0.0046 \rho \gamma s \left( k h \rho_{\text{ef}} + 3.0 \right) \text{mm}, \]

\[ t = 8.5 \text{ mm}, \text{ whichever is the greater} \]

In the case of grab dredgers the minimum thickness is to be 10 mm. These thickness requirements also apply to the plating of watertight box keels and inner bottom plating. The value of \( \rho_{\text{ef}} \) used in the calculations and the height(s) of the overflow weir(s) are to be clearly shown on the midship section plan.

8.3.2 Attention is drawn to the high rate of wear that can occur on spoil space boundaries, and it is recommended that an additional corrosion allowance of 3.0 mm be added on areas subject to particularly onerous conditions. Where such an allowance is added, the fact is to be marked on the relevant plans.

8.3.3 The thickness of plating forming the sides and ends of bucket ladder wells is to be not less than:

\[ t = (0.0055s \sqrt{T_m} + 3.0) \text{ mm} \]

In no case, however, is the side plating to have a thickness less than 12 mm nor is the well end plating to have a thickness less than 8.5 mm. Plating forming the boundaries of suction pipe ladder wells is generally to be required for shell plating. Corrosion allowance on well end plating below bucket ladders may be 2.0 mm.

8.3.4 The thickness of spoil space and ladder well bulkheads may be required to be increased where high shear forces are present.

8.3.5 Bulkheads forming the boundaries of spud wells are to be of increased strength. Each case will be considered on its merits, but in general such bulkheads should have a thickness of not less than 12 mm.

8.3.6 Where non-watertight bulkheads are fitted in the side buoyancy tanks, the thickness of the plating is to be not less than:

(a) \[ t = 6.5 \text{ mm}, \]

(b) \[ t = (5.35 + 0.024L) \text{ mm} \]

whichever is the greater. Where the bulkhead is in the form of a wash bulkhead, the openings should be so arranged that, in general, the distance from lightening holes to any slots cut to accommodate side shell or bulkhead longitudinals is at least equal to 1.5 times the depth of the slot. The edges of large openings are to be stiffened.

8.3.7 The section modulus of framing on spoil space boundaries is to be not less than:

\[ Z = 0.0113 \rho_{\text{ef}} s h t^2 k c \text{ cm}^3 \]

where

\[ c = \text{as defined in Table 12.8.2 for longitudinal framing} \]

\[ \gamma = 1.0 \text{ for transverse framing} \]

\[ \rho_{\text{ef}} = \text{effective specific gravity, see Pt 3, Ch 2.1} \]

\[ k = \text{higher tensile steel factor, see Pt 3, Ch 2.1} \]

The section modulus of longitudinals below \( \frac{D}{2} \) is to be taken not less than the value obtained at \( \frac{D}{2} \).

Table 12.8.2 Definition of c for longitudinal framing

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Location</th>
<th>c, see Note 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_B ) as defined in Pt 3, Ch 4.5.1</td>
<td>( \frac{D}{2} ) and above</td>
<td>1.0</td>
</tr>
<tr>
<td>( F_B ) as defined in Pt 3, Ch 4.5.1</td>
<td>At ( \frac{D}{2} )</td>
<td>0.85</td>
</tr>
<tr>
<td>( \frac{0.2D}{2} ) above base (see Note 1)</td>
<td>550</td>
<td></td>
</tr>
<tr>
<td>( 1590 )</td>
<td>3620 – 1560 ( F_B )</td>
<td></td>
</tr>
<tr>
<td>Base line (see Note 1)</td>
<td>2060</td>
<td>3620 – 1560 ( F_B )</td>
</tr>
</tbody>
</table>

NOTES

1. For ships with hogging still water bending moments in loaded conditions and for split hull vessels, \( c = 1.0 \).

2. Intermediate values are to be calculated by linear interpolation.

8.3.8 The section modulus of stiffeners bounding wells and deep tanks is to satisfy the requirements of Ch 1.9.2.

8.3.9 For non-watertight bulkheads, the modulus of the stiffeners may be 50 per cent of that required for intact bulkheads. The stiffeners are to be bracketed at top and bottom.
8.3.10 Structure supporting spud well platting and bulkheads below, and in way of, ‘A’ frames and dredging machinery supports, is to be of substantial construction, account being taken of the dynamic loads likely to occur with the dredging machinery in operation.

8.3.11 Horizontal girders supporting stiffeners on spoil space and ladder well boundaries are, in general, to have scantlings as required by Ch 1,9.2 for deep tanks, with \( p \) and \( h \) as defined in 1.5.1 and 8.1.1 respectively and with span, \( l_e \), for horizontal girders supporting vertical stiffeners on longitudinal bulkheads, measured between bulkhead bracket and bulkhead bracket, i.e., ignoring any struts which may be fitted between spoil space girder and shell stringer. Alternatively, the section modulus of these horizontal girders may be reduced by 40 per cent from the formula value if struts are fitted on alternate frames between the spoil space girder and a shell stringer. These struts should generally be horizontal and are to have a sectional area as required for pillars by Ch 1,4.4 with \( p \) as defined in 1.5.1 and \( h \) measured from the inboard end of the strut to the height defined in 8.1.1. Web frames and girders are to have scantlings as required by Chapter 1, with \( p \) and \( h \) as defined in 1.5.1 and 8.1.1 respectively.

8.4 Cross-members

8.4.1 Cross-members are to be fitted within the hopper space in line with the bottom and side shell transverses and with the bulkheads in the side buoyancy spaces. Where the spacing between the cross-members exceeds 4 m, the scantlings of all primary members contributing to the continuity of the transverse strength in the spoil space are to be verified by direct calculations, see also Pt 3, Ch 2,1.2. Where a box keel is fitted on the centreline, webs are to be fitted within the box keel to ensure proper continuity of strength across the ship in way of the hopper cross-member. The webs required within centreline watertight box keels may have a thickness 3.5 mm less than that required for the hopper cross-members with which they are associated, but their minimum thickness is to be not less than 6.5 mm.

8.4.2 The upper edge of the hopper lower cross-members should, in general, be a height of not less than \( \frac{D}{4} \) above the above the keel in ships with the number 100 in their character of classification. The lower edge should be as low as practicable after allowing for the proper design of hopper doors, suction passages, etc. Lower cross-members may be fabricated from flat plate suitably stiffened or may take the form of a hollow box, generally of triangular cross-section.

8.4.3 The scantlings of box-type cross-members should be determined from the requirements for hopper bulkheads where applicable. When flat plate lower cross-members are fitted, the thickness of the web is to be not less than:

\[
t = (0.7B + 3) \text{ mm or } 8.5 \text{ mm whichever is the greater.}
\]

8.4.4 The cross-sectional area of the cross-member web after deducting access openings, lightening holes, etc., is to be not less than:

\[
A = 6h_wS_M \text{ cm}^2
\]

where

\[
h_w = \text{height, in metres, of the uppermost hopper overflow weir above the keel}
\]

\[
S_M = \text{spacing of the cross-member webs, in metres.}
\]

8.4.5 The upper edge of the cross-member is to be stiffened by means of a tube having an outside diameter not less than:

\[
\delta = 30l_s \text{ mm}
\]

where

\[
l_s = \text{span, in metres, of the upper edge of the cross-member (to the centreline box girder if fitted),}
\]

and a thickness equal to the minimum required cross-tie web thickness, or by an equivalent flange or structure. The lower edge of the cross-member is also to be suitably stiffened.

8.4.6 The cross-member web is to be fitted with stiffeners, spaced not more than 800 mm apart having a modulus of not less than:

\[
Z = 0.04s l_s^2 \text{ cm}^3.
\]

8.4.7 The transverse strength of primary structural members, such as upper and lower cross members and wing tank bulkheads, forming transverse ring systems are to be verified by direct calculations, e.g., finite element calculations on the basis of loads arising from hydrostatic, wave, spoil pressure and loadings on closing apparatus of bottom openings. The stresses in general not to exceed the following values:

- **Bending + axial stress** \( (\sigma_B) \): 130/\( k \) N/mm\(^2\)
- **Shear stress** \( (T) \): 70/\( k \) N/mm\(^2\)
- **Combined stress** \( (\sigma_C) \): 180/\( k \) N/mm\(^2\)

where \( k = \text{higher tensile steel factor, see Pt 3, Ch 2,1.} \)

8.5 Pillars within hoppers

8.5.1 Pillars are generally to comply with the requirements of Ch 1,4.4, account being taken of the maximum forces that can be applied by rams or other gear fitted for the purpose of activating hopper doors or valves.

8.6 Continuous coamings

8.6.1 Continuous coamings are to have a plate thickness of not less than 8.5 mm. A minimum thickness of 10 mm is recommended for coamings on grab dredgers. Where the depth of the coaming exceeds 80t, the plating is to be stiffened by one or more horizontal members so spaced that the width of the upper panel of plating does not exceed 65t and the width(s) of the lower panel(s) do(es) not exceed 80t.
8.6.2 Where the coaming is stiffened with flat bar members, the members are to have a breadth not less than \(0.04S_s\) and a thickness not less than \(0.05\) times their breadth, or 8.5 mm, whichever is the greater. They are to have a minimum inertia of:

\[ I = 2S_s^2 A_1 \, \text{cm}^4 \]

where \(A_1\) and \(I\) include the coaming plating for mid-panel above to mid-panel below the stiffener, and \(S_s\) = spacing of the brackets required by this sub-Section, in metres.

Where stiffeners other than flat bars are used, they are to have at least the same minimum thickness and inertia as required for flat bars.

8.6.3 The upper edge of the coaming is to be stiffened by a fabricated flange, box girder or equivalent structure having a width not less than \(0.05S_s\) and an inertia not less than:

\[ I = 2.86S_s^2 A_1 \, \text{cm}^4 \]

where \(A_1\) and \(I\) include the coaming plating down to mid-panel below.

The thickness and/or attachments of the stiffening member are to be such as to minimise any likelihood of local instability under compression loading.

8.6.4 The coamings are to be supported by substantial brackets spaced generally not more than 3.0 m apart where the coamings have a height of more than 600 mm, nor more than 2.5 m where the coamings have a height of more than 1.0 m but on longitudinally framed ships the brackets are to be arranged in way of each deck transverse. Additional brackets may be required in way of the ends of hopper upper cross-ties, especially those which themselves support hopper door operating rams or similar equipment.

8.6.5 The ends of continuous coamings are to be well scarfed into the ship’s structure at the ends of spoil spaces. Unless longitudinal deckhouse bulkheads are fitted in this area, the coamings are to be extended beyond the end of the spoil space opening for a distance of at least one frame space, or 1.5 times the coaming height, whichever is the greater.

(a) Suitable structural compensation is arranged; and
(b) the stability is checked in the damaged condition.

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**Section 10**

**Exposed casings**

10.1 Scantlings and access

10.1.1 Exposed casings on ships classed \(A1\) protected waters service are to have scantlings as required for deck-houses on dry cargo ships classed 100A1. On ships classed 100A1, where \(T_m\) equals or exceeds the draught corresponding to a Type ‘B-60’ ship freeboard, direct access is not permitted to the machinery spaces (including dredging pump-rooms) from the freeboard deck. Doors may be fitted in exposed casing bulkheads, provided that they lead to a space which is of equivalent strength to the casing and is separated from the machinery space by a second watertight door.

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**Section 11**

**Dredging machinery seats and dredging gear**

11.1 Dredging machinery seats

11.1.1 The seats supporting the main dredging machinery are to be at least as substantial as those required for the main propulsion machinery for dry cargo ships, see Pt 3, Ch 7.6. Continuity between the longitudinal and transverse members of main engine seats and the ship’s bottom structure is to be arranged where practicable. Where floors are cut away below dredging pumps, they are to be fitted with face bars, and special care is to be taken to minimise stress-raising details and to ensure good workmanship.

11.2 Dredging gear

11.2.1 Where masts or derrick posts support dredging gear which will be subjected to vibration or other dynamic loads in addition to its true weight, this must be taken into account in the calculations. The dynamic multiplier should be taken between two and three according to the type of machinery and gear used.
**Section 12**

**Ladder wells**

12.1 **Transverse strength at deck**

12.1.1 Where ladder wells are incorporated so that the length of the well exceeds 1.5 times the width of the deck remaining on each side of the well, the portions of the ship on each side of the well are to be adequately cross-connected in the region of their free ends, unless the design of the ship renders this impracticable, in which case alternative arrangements are to be made to avoid high stress concentrations at the inboard end of the well.

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**Section 13**

**Fenders**

13.1 **Fenders and reinforcement in way**

13.1.1 Dredgers designed to work in conjunction with hopper barges are to be fitted with permanent rubbing strakes or fenders extending down to their lowest normal operating waterline. On transversely framed vessels it is recommended that the side structure in way of the lower edge of the fender be reinforced by a stringer and/or cross-ties. It is recommended that, where wooden fenders are fitted to dredgers operating in tropical sea-water, the fenders be cut just above the deepest working waterline and a gap be left sufficient to prevent water soaking up into the fenders.

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**Section 14**

**Rudders**

14.1 **Rudders on bucket dredgers**

14.1.1 Where bucket dredgers are arranged with bucket ladders at their stern, the ship’s rudders are to be kept well clear of the buckets to minimise the likelihood of damage to the rudders by large objects which may be dredged up. For rudder calculations, see Pt 3, Ch 13.

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**Section 15**

**Spoil space weirs and overflows**

15.1 **General**

15.1.1 All spoil spaces are to be arranged to allow the safe and efficient overboard discharge of excess water in all weather conditions in which the ship is classed to operate. In ships over 90 m in length and in all ships classed for unrestricted service the spoil space overflows are to be arranged via enclosed overflow trunks so designed as to keep the decks of the ship clear of spoil and water.

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**Section 16**

**Scuppers and sanitary discharges and side scuttles**

16.1 **General**

16.1.1 In all areas where mechanical damage might be likely, all side scuttles, scuppers and discharges, including their valves, controls and indicators, are to be well protected. Consideration is to be given to the likelihood of impact damage to scuttles and discharges due to barges coming alongside, and to scuppers becoming blocked by sand or other spoil which may spill onto the decks or other areas being drained.

16.1.2 Consideration will be given to requests for relaxation of requirements relating to scuttles, scuppers and discharges on ships classed A1 protected waters service.
17.1 Symbols and definitions

17.1.1 The symbols used in this Section are defined as follows:

- \( I = \) height of spoil above base line, in metres
- \( H = \) depth of hopper seal, in metres
- \( L_h = \) length of hopper well, in metres
- \( M_H = \) design horizontal bending moment in hopper side wall, in kNm (tonne-f m). A moment giving rise to tensile stress in the side shell is to be taken as positive
- \( N = \) net pressure per metre ship length resulting from the spoil pressure and the hydrostatic load, see Fig. 12.17.2
- \( P = 4.9 \left[ \frac{H + H_0}{2} - 1.025 \left( T + H_0 \right)^2 \right] \) kN/m
- \( S_h = \) span between the centres of hinges, in metres

17.1.2 Other symbols are defined in 1.5.1.

17.2 Hull bending strength

17.2.1 The modulus of the cross-section of the vessel is to be not less than that required by 2.3.1. In addition, the combined stress \( \sigma_c \), at any point on the cross-section of one half hull, is not to exceed the permissible combined stress \( \sigma_p \) given in Pt 3, Ch 4.5.5. The combined stress at any point on the cross-section is to be determined from the following expression:

\[
\sigma_c = \left( \frac{M_N}{Z_N} + \frac{M_D}{Z_D} \right) \times 10^{-3} \text{ N/mm}^2 (\text{kgf/mm}^2)
\]

where

\[
M_N = \pm M_Y \cos \phi \pm M_I \sin \phi \quad \text{kNm (tonne-f m)}
\]

\[
M_D = \pm M_Y \cos \phi \pm M_I \sin \phi \quad \text{kNm (tonne-f m)}
\]

\[
M_H = \pm 0.5 \left( M_D + M_N \right) \quad \text{kNm (tonne-f m)}
\]

where the still water bending moments hogging and sagging are to be combined with the appropriate wave bending moment to give a total moment, \( M_H \), hogging (positive) and sagging (negative).

\( M_N \) is defined in 1.5.1.

\( f_1 = \) ship service factor, see Table 12.2.1

\( M_{H} = 0.125 P \left( SL_1 + L_2 - L_0 \right) \pm M_I \quad \text{kNm (tonne-f m)} \)

\( M_L = 0.286 f_1 L^2 B \quad \text{kNm (0.029 f_1 L^2 B \quad \text{tonne-f m})} \)

\( P = 4.9 \left[ \frac{(H + H_0)^2}{2} - 1.025 (T + H_0)^2 \right] \quad \text{kNm (0.5 (H + H_0)^2 - 1.025 (T + H_0)^2 \quad \text{tonne-f m})} \)

Account is to be taken of the sign of individual bending moment component in the determination of \( M_N, M_D, M_Y \) and \( M_H \).

\( I_{NN} = \) second moment of area of the section of one half hull for all longitudinal continuous material about principal axis NN, in m^4

\( I_{PP} = \) second moment of area of the section of one half hull for all longitudinal continuous material about principal axis PP, in m^4

\( Z_p = \frac{I_{PP}}{y_p} \quad \text{in m}^3, \text{ the modulus of section to a point } y_p \text{ m, from the principal axis PP} \)
17.4 Hinge pins

17.4.1 The diameter of the hinge pins is to be determined using the maximum resultant shear force acting on the pin cross-section in conjunction with an average shear stress not exceeding \( \frac{62}{k} \) N/mm\(^2\) \( \left( \frac{6.3}{k} \right) \) kgf/mm\(^2\).

In no case is the diameter of the hinge pin to be less than that calculated from the following expression:

\[
D_p = 20 \sqrt{\frac{L_{0.5} B D K}{n}} \text{ mm}
\]

where
- \( k \) = higher tensile steel factor, see Pt 3, Ch 2.1
- \( n \) = the number of pin cross-sections resisting shear forces
- \( L, B \) and \( D \) are defined in 1.5.1.

17.4.2 Where arrangements are such that hinge pins are subjected to significant bending, the diameter of the pins will be specially considered.
Section 18
Direct calculations

18.1 Application

18.1.1 Direct calculations may be used to assess the scantlings of primary structure in spoil spaces and adjacent structure.

18.1.2 Direct calculations may be required to be submitted in respect of unusual structural arrangements.

18.2 Procedures

18.2.1 Methods applied for direct calculations of scantlings will be given individual consideration dependent on the particular structural configuration, see also Pt 3, Ch 1,3.1.