THE SOCIALIST REPUBLIC OF VIETNAM

QCVN 56: 2013/BGTVT

NATIONAL TECHNICAL REGULATION ON CLASSIFICATION AND CONSTRUCTION OF SHIPS OF FIBREGLASS REINFORCED PLASTICS

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Preamble

National Technical Regulation on Classification and Constructions of Ships of Fibreglass Reinforced Plastics QCVN 56: 2013/BGTVT is compiled by Vietnam Register, verified by the Ministry of Science and Technology, promulgated by the Minister of Transport under Circular No. 06/2013/TT-BGTVT dated 2 May 2013.

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1.1 Application and Scope

1.1.1 Application

1 The present National Technical Regulation (hereinafter referred to as “Regulations”) applies to ship made of reinforced plastic fiberglass (hereafter referred to as "FRP ships") which are subject to the technical survey and classified by Vietnam Register.

2 Relevant requirements in QCVN 21: 2010/BGTVT "National technical regulations for Classification and Construction of sea-going steel ships" also apply to FRP ships, except otherwise specified in this Regulation.

3 The requirements of this regulation apply to FRP ships have the unlimited activities, excluding oil and ships, smaller 35 meters in length, shape and size of general use rate.

4 The structure of the hull, equipment and the treatment of the calculation of the FRP hull structure has the limited activities may be appropriate changes depending on the condition of exploitation.

5 The provisions of this Regulation are applied for FRP ships forming by the method of manually or injection methods, using unsaturated polyester resin and glass fibre reinforced. The wooden ship was only wrapped with FRP or the ships have the same texture will not be considered to be FRP ships.

6 With the FRP ships shaped or unusual size ratio, FRP ships used to transport the goods, or FRP ships is shaped according to the method, or by other materials with prescribed in-5, then the hull structure, the equipment, the layout and dimensions must be considered individually register in each specific case.

1.1.2 Scope

The present Regulation is to apply to organizations and individuals involving activities relating to FRP ships and falling under the application as specified in 1.1.1 above, including Vietnam Register (hereinafter referred to as "VR"); FRP ship owners (hereinafter referred to as "Owner"); operators, designers, building, renovating and repairing yards.

1.2 References, Definitions and Explanations

1.2.1 References

1 QCVN 21: 2010/BGTVT: National technical Regulations for the Classification and Construction of sea-going steel ships promulgated in accordance with No. 12/2010/TT-BGTVT dated April 21st 2010 of the Ministry of Transportation.

2 QCVN 23: 2010/BGTVT: National technical Regulations of ship lifting promulgated in accordance with Circular No. 11/2010/TT-BGTVT dated April 20th 2010 of the Ministry of Transportation.

3 Circular No. 32/2011/TT-BGTVT: Circular to amend numbers of requirements of regulations on the survey, classification and registration of Vietnamese sea-going ships April 19th 2011 promulgated under the Decision No. 51/2005/QĐ-BGTVT dated 12th October 2005 by the Minister of Transport.

1.2.2 Definitions and Explanations

1 General

The definitions of terms which appear in these Regulations are to be as specified in Part 1A, Section II of QCVN 21: 2010/BGTVT, unless specified as bellows.

2 Length of Ship

Length of ship (L) is the distance in metres on the designed maximum load line defined in 2.2-7(2), from the fore side of stem to the aft side of rudder post in case of a FRP ships with rudder post, or to the axis of rudder stock in case of a FRP ship without rudder post. However, in case of a FRP ships with cruiser stern, L is as defined above or 96% of the total length on the designed maximum load line, whichever is greater.

3 Breadth of Ship

The breadth of ship (B) is the horizontal distance in metres between the outside of side shell laminates measured on the upper surface of upper deck laminates at side at the broadest part of the hull.

4 Depth of Ship

The depth of ship (D) is the vertical distance in metres from the lower surface of bottom laminates or from the intersection of the extension line of lower surface of bottom laminates with the centre line of ship (hereinafter referred to as base point of D) to the upper surface of upper deck laminates at side measured at the middle of L.

5 Midship Part of Ship

The midship part of ship is the part for 0.4L amidships unless otherwise specified.

6 End Parts of Ship

The end parts of ship are the parts for 0.1L from each end of the ship.

7 Load Line and Designed Maximum Load Line

(1) Load line is the water line corresponding to each freeboard assigned in accordance with the provisions of Part 11, Section II of QCVN 21: 2010/BGTVT;

(2) Designed maximum load line is the water line corresponding to the full load condition.

8 Load Draught and Designed Maximum Load Draught

(1) Load draught is the vertical distance in metres from the top of keel plate to the load line;

(2) Designed maximum load draught (d) is the vertical distance in metres from the top of keel plate to the designed maximum load line measured at the middle of L.

9 Freeboard Deck

Freeboard deck is specified in 1.2.1-25 Part 11, Section II of QCVN 21: 2010/BGTVT.

10 Strength Deck

The strength deck at a part of ship's length is the uppermost deck at that part to which the shell laminates extend. However, in way of superstructures, except sunken

superstructures, which are not considered effective to longitudinal strength, the strength deck is the deck just below the superstructure deck.

11 Fibreglass Reinforcements

The fibreglass reinforcements are glass chopped strand mats (hereinafter referred to as chopped mats), glass roving cloths (hereinafter referred to as roving cloth) and glass roving (hereinafter referred to as rovings) of reinforcements for FRP manufactured from long fibres.

12 Resins

The resins are liquid unsaturated polyester resins for laminating and gelcoat.

13 Blending Proportion

The blending proportion is a ratio in weight of the applied curing agents and accelerator to the resin or the ratio in weight of the curing agents used to the base resins of structural adhesives.

14 Laminating

Laminating is an operation of laying succeeding glass fibre reinforcement impregnated with resin before curing or before the preceding layer advances in cure.

15 Bonding

Bonding is an operation of connecting the FRP already advanced in cure with other FRP members, timbers, hard plastic foams, etc. by means of impregnating fibreglass reinforcements with resin or structural adhesives.

16 Moulding

Moulding is an operation of manufacturing FRP products with definite form, strength, etc., by means of laminating or bonding.

17 Single Skin Construction

The single skin construction is a construction composed of FRP single panels moulded with fiberglass reinforcement and resin.

18 Sandwich Construction

The Sandwich construction is a construction having FRP layers adhered to the both sides of core material such as hard plastic foam, balsa, timber (including plywood), etc.

19 Hand Lay-up Method

The hand lay-up method is a method of manual moulding by impregnating fibreglass reinforcements with resin.

20 Spray Lay-up Method

The spray lay-up method is a method of moulding by spraying simultaneously fibreglass reinforcements and resin using spray lay-up apparatus.

21 The ship in the early stages of the new building

(1) Ships in the first stage of the process is that ship new building:

(a) The structure is formed has can recognize the ship; and

(b) The installation of the ship that began at least 50 tonnes or 1% of the estimated mass of all structural material, retrieved a value smaller than.

22 Major conversion

(1) Major conversion means a conversion of an existing ship:

(a) Change the size of the vessel or the vessel's carrying capacity;

(b) Which changes the type of the ship;

(c) Ship upgrades.

II TECHNICAL REGULATIONS

CHAPTER 1 GENERAL

1.1 General

1.1.1 Equivalency

Alternative FRP ship construction, equipment, arrangement and scantlings will be accepted by VR, provided that VR is satisfied that such construction, equipment, arrangement and scantlings are equivalent to those required in this Regulation.

1.2 General regulations on ship design

1.2.1 Structure and equipment

Stern frame, steering gear, steering column, machines and equipment are to be in accordance with requirements in the corresponding sections of QCVN 21: 2010/BGTVT.

1.2.2 Stability and Freeboard

Stability, freeboard of FRP ships specified in Part 10 and 11 Section II of QCVN 21: 2010/BGTVT.

1.2.3 Passenger ship

In addition to the requirements of this Regulation, hull construction, equipment, arrangement and scantlings are to be specially considered separately based on design features in accordance with Part 8F Section II of QCVN 21: 2010/BGTVT.

1.2.4 Scantlings

1 The scantlings required in these Regulations are specified for FRP ships moulded with fiberglass reinforcements composed of chopped mats and roving cloths and moulded with FRP having the strength specified in the following (1) to (4), but excluding gelcoats:

(1) Tensile strength: 98 N/mm^2

(2) Modulus of tensile elasticity: 6.86×10^3 N/mm^2

(3) Bending strength: 150 N/mm^2

(4) Modulus of bending elasticity: 6.86×10^3 N/mm^2

2 For single skin construction the scantlings specified in these Regulations may be modified by multiplying by the factors specified in the following (1) and (2) in case where moulded with an FRP having the strength higher than specified in the preceding -1.

(1) For the thickness, a factor obtained from the following formula:

$$\sqrt{\frac{15}{\sigma_B}}$$

Where:

σ_B: Bending strength of the FRP obtained from the material tests specified in 4.4.4 (kg/mm^2).

(2) For the section modulus (including section modulus of the transverse section of hull), a factor obtained from the following formula:

$$\frac{98}{\sigma_T}$$

Where:

σ_T: Tensile strength of the FRP obtained from the material tests specified in 4.4.4(kg/mm^2).

3 In case where the scantlings of laminates of sandwich construction are calculated, the modulus of bending elasticity of the inner or outer layer of FRP of laminates if sandwich construction may be as obtained from the material tests specified in 4.4.4.

4 In calculating the section modules of structural members, the actual FRP laminates of 150 mm on either side of the web are to be included.

1.2.5 Hat-type Construction

1 The minimum thickness of webs and faces of girders, beams, frames, floors, etc., of hollow hat-type or hat-type with cores for moulding are not to be less than obtained from the following formula:

Thickness of web: $0.034d_0K$ (mm)

Thickness of face: $0.05bK$ (mm)

Where:

d_0: Depth of web (mm);

b: Breadth of face (mm);

K: 1.0. However, where the section modules of the members exceeds the specified value, the value as obtained from the following formula may be taken as K:

$$\sqrt{\frac{Z_R}{Z_A}}$$

Where:

Z_R: Section modules specified for the member;

Z_A: Actual section modulus of the member.

2 The core for moulding may be reckoned in the strength at the discretion of VR.

3 Other scantlings are to be in accordance with the requirements in the relevant chapters.

1.2.6 Sandwich Construction

1 The core of sandwich construction composing a panel is to be, as a rule, composed by one layer. The thickness of core is not to be larger than 25 mm. However, the composition of core different from these is to be at the discretion of VR.

2 The ratio of the thicknesses of outer and inner layers of FRP is not to be less than 0.8. In case where the ratio of the thicknesses of outer and inner layers is less than 0.8, the construction will be specially considered by VR.

3 The cores may be reckoned in the strength at the discretion of VR.

4 Other scantlings are to be in accordance with the requirements in the relevant chapters.

1.2.7 Weight of Fibreglass Reinforcements and Thickness Laminates

1 The thickness of laminates per play of chopped mats or roving cloths may be as obtained from the following formula:

$$\frac{W_G}{10\gamma_R G} + \frac{W_G}{1000\gamma_G} - \frac{W_G}{1000\gamma_R} \quad \text{(mm)}$$

Where:

W_G: Designed weight per unit area of chopped mats or roving cloths, g/m^2;

G: Glass content of laminate (ratio in weight) (%);

γ_R: Specific gravity of cured resin;

γ_G: Specific gravity of chopped mats or roving cloths.

2 The glass content (G) specified in the preceding -1 is preferable to be the value per ply for the actual laminates. However, it may be taken as the mean glass content of the whole laminates.

3 The specific gravity of chopped mats or roving cloths (γ_G) specified in the preceding -1 may by taken as 2.5 in calculation of the thickness, if nothing specially intervenes.

4 The specific gravity of cured resin (γ_R) specified in the preceding -1 may be taken as 1.2 in calculation of the thickness, unless any fillers are used in order to make the resin heavier.

5 Calculation of the thickness of laminates with fibreglass reinforcements other than chopped mats and roving cloths is to be in accordance with the discretion of VR.

1.2.8 Ship Identification Number

1 For cargo ships not less than 300 gross tonnage engaged on international voyages, the ship's identification number is to be permanently marked as follows:

(1) Those specified in 1.1.24 Part 2A Section II of QCVN 21: 2010/BGTVT (except -2(3));

(2) The marking is to be made by a method approved by VR not to be easily expunged.

CHAPTER 2 CLASSIFICATION SURVEY

2.1 General

1 The class surveys of FRP ships are to be, except those specified in this Chapter, in accordance with the requirements in Part 1B, Section II of QCVN 21: 2010/BGTVT.

2 In the surveys of FRP ships less than 20 m in length, the items, extent and degree of survey may be properly modified, where deemed appropriate by VR.

3 In the first Intermediate Survey after construction, the internal inspection of fuel oil tanks made of FRP is to be carried out.

2.2 Classification Survey during Construction

2.2.1 General

1 In the classification survey during construction, the hull and equipment, machinery, fire protection and detection, means of escape, fire extinction, electrical installation, stability and load lines are to be examined in detail in order to ascertain that they meet the requirements in the relevant chapters.

2 The new installation of materials which contain asbestos is to be prohibited.

2.2.2 Plans and Documents for Approval

1 With respect to FRP ships intended for the classification survey during construction, the plants and documents listed in the following (1) to (3) are, prior to the commencement of work, to be submitted for the approval by VR:

(1) Hull:

(a) List and data of raw materials;

(b) General arrangement;

(c) Midship section (showing athwartships sections at the holds and machinery space, and in way of the wingtanks, if provided, and also indicating the characters of intended classification and the load draught);

(d) Details of fore and aft construction, and stem and stern frame;

(e) Propeller post and rudder (including materials and ship’s speed);

(f) Construction profile (showing arrangement of watertight bulkheads, load draught, sizes of brackets and athwartships sections of the ship at 0.1L and 0.2L from the ends of the ship);

(g) Deck plans (indicating arrangement and construction of hatchways, hatch beams, etc.);

(h) Single bottoms and double bottoms;

(i) Watertight and oiltight bulkheads (indicating the highest position of tank and position of tops of overflow pipes);

(j) Superstructures end bulkheads (indicating the construction of doors);

(k) Seatings of boilers, main engines, thrust blocks, plummer blocks, generators and other important auxiliary machinery (indicating output, height and weight of main engines and arrangement of holding-down bolts);

(l) Steering gear (indicating details of structural arrangement and materials);

(m) Laminating procedure and details of joints;

(n) Plans showing arrangement of ship's identification number specified in 1.3.8.

(2) Machinery:

Plans and documents in relation to the machinery specified in 2.1.2-1(2) Chapter 2 Part 1B Section II of QCVN 21: 2010/BGTVT.

(3) Other plans and documents deemed necessary by VR.

2.2.3 Plans and Documents to be submitted for Reference

1 Where intended for the classification survey during construction, the following plans or documents are to be submitted for reference, in addition to those for approval required in 2.2.2:

(1) Specifications;

(2) Certificates of FRP material tests specified in Chapter 4;

(3) Moulding procedure;

(4) Calculation sheets and information with respect to structural strength;

Where load lines are to be marked in accordance with the requirements in Chapter 20, plans and documents specified in 2.1.3-1(4) Chapter 2 Part 1B, Section II of QCVN 21: 2010/BGTVT.

2 Plans and documents other than specified in the preceding **-**1 and -2 may be required to be submitted, where deemed necessary by VR.

2.2.4 Inspections during Construction

1 In the classification survey during construction, inspections are to be carried out covering all stages of the moulding work from its commencement until its completion.

2 The presence of the Surveyor is required at the following stages of the work in relation to hull:

(1) When the tests of FRP materials specified in Chapter 4 are carried out.

(2) When designated by VR during moulding work.

(3) When the strength tests of FRP specified in Chapter 4 are carried out.

(4) When the moulding are connected (e.g., shell to deck).

(5) When the materials or parts manufactured away from the site are applied to the FRP ships concerned.

(6) When hydrostatic tests and watertight tests are carried out.

(7) When sea trials are carried out.

(8) When deemed necessary by the VR.

3 With respect to the work in relation to machinery and equipment, the presence of the Surveyor is to be in accordance with the requirements in 2.1.4 Chapter 2 Part 1B Section II of QCVN 21: 2010/BGTVT.

4 The stages of work for which the presence of the Surveyor is required in the preceding -2, may be modified in accordance with the actual status of facilities, technical abilities and quality control system at the works, except the case of the sea trials.

2.3 Classification Survey Not Built under Survey

2.3.1 General

1 In the classification survey of FRP ships not built under VR's survey, the actual scantlings of main parts of the ship are to be measured in addition to such examinations of the hull and equipment, machinery, fire protection and detection, means of escape, fire extinction, electrical installations, stability and load lines as required for the special survey corresponding to the ship's age.

2 As for FRP ships intended for the classification survey specified in the preceding -1, plans and documents required for the classification survey during construction are to be submitted.

CHAPTER 3 WORKSHOPS

3.1 General

3.1.1 Application

Workshops intended to manufacture FRP ships and their facilities are to be in accordance with the requirements in this Chapter.

3.1.2 Workshops

The workshops with manufacture FRP ships intended to be registered to VR, are to submit detailed data on the facilities of the moulding shops and the storage facilities for raw materials, and are to be inspected by the Surveyor.

3.2 Laminating Shops

3.2.1 Construction and Arrangement of Laminating Shops

1 The laminating shops are to be so arranged as to be properly subdivided or partitioned in order that the shops are separated from each other during laminating operation.

2 The laminating shops are to be of such construction as to be free from penetration of draught, dust, moisture, etc.

3 The facilities and their arrangement of the laminating shops are to be made reasonable in consideration of handling raw materials, laminating process, etc.

3.2.2 Ventilation Facilities

In providing the laminating shops with ventilation facilities, thorough considerations are to be given so that they should not give any bat influence upon the curing of laminates.

3.2.3 Temperature Conditioners

The laminating shops are to be provided with temperature conditioners to keep the room temperature suitable for use of resins during laminating operation.

3.2.4 Relative Humidity

1 In the laminating shops, the relative humidity during laminating operation is to be kept suitable.

2 If necessary, suitable dehumidifying appliances to be provided.

3.2.5 Shielding

The skylights and windows of the laminating shops are to be provided with suitable means of shielding so that the laminates are not exposed direct to the sun.

3.2.6 Dust Collectors

The laminating shops are to be provided with suitable dust collectors in order to get rid of dusts yielded during laminating operation.

3.3 Storage Facilities for Raw Materials

3.3.1 Equipment and Arrangement of Storage Facilities

The equipment and arrangement of the storage facilities for raw materials are to be reasonable in connection with the storage and handling of the materials.

3.3.2 Stores for Resins, etc.

The resins, curing agents, accelerators and structural adhesives are to be stored in cool and dark spaces.

3.3.3 Stores for Fibreglass Reinforcements

The fibreglass reinforcements are to be stored in dust-free and dry spaces.

CHAPTER 4 MATERIALS FOR HULL

4.1 General

4.1.1 Application

The requirements in this Chapter are framed for FRP and their raw materials, etc. The metallic materials are to be in accordance with the requirements in Part 7A Section II of QCVN 21: 2010/BGTVT.

4.1.2 Raw Materials for Primary Structures

The fibreglass reinforcements, resins for laminates, core materials for sandwich construction and structural adhesives to be used for FRP ships are to be tested and inspected in the presence of the Surveyor and to be accepted, except those approved by VR in accordance with the requirements in 4.2.

4.2 Approval

4.2.1 Approval of Raw Materials

1 At the request of raw material manufacturers, VR will examine the materials used, manufacturing methods, inspection standards in the workshop, quality control system, etc., for the raw materials listed in the following (1) to (4) and execute tests and inspections specified in this Chapter on the test samples designated by VR. Where the test samples have passed these tests and inspections, they are dealt with as the approved materials:

(1) Fibreglass reinforcements;

(2) Resins for laminates;

(3) Core materials for sandwich construction.

4.2.2 Continuation of Approval

1 The raw material manufacturer intending to obtain continuation of the approval, is subjected to periodical surveys, as a rule, at intervals not exceeding one year, in accordance with the requirements in the following (1) and (2):

(1) Examinations of the materials used, manufacturing methods, inspection standards in the workshop, quality control system, etc.;

(2) Tests and inspections designated by VR.

4.2.3 Withdrawal of Approval

1 In case where the approved materials correspond to either one of those specified in the following (1) to (3), the approval of material by VR is to be withdrawn:

(1) When the materials used, manufacturing methods, inspection standards in the workshop, quality control system, etc., are worse than those at the time of approval and deemed inadequate;

(2) When the approved materials have not passed the specified periodical inspections;

(3) When the specified periodical inspections are not carried out.

4.3 Raw Materials, etc.

4.3.1 Test and Inspections of Fibreglass Reinforcements

1 The tests and inspections specified in 4.1.2 for fibreglass reinforcements to be used for the full structures of FRP ships are to be in accordance with the requirements in the following -2 to -4. In this case, the procedures of tests and inspections are to be in accordance with the discretion of VR.

2 Chopped mats are to be tested and inspected on the items listed in the following (1) to (5):

(1) Appearance;

(2) Weight per unit area and its maximum deviation;

(3) Ratio in weight of residual binders (including sheafing agents);

(4) Bending strength and modulus of bending elasticity obtained from laminated test specimens (in the standard condition);

(5) Tensile strength and modulus of tensile elasticity obtained from laminated test specimens (in the standard condition).

3 Roving cloths are to be tested and inspected on the items listed in the following (1) to (6):

(1) Appearance;

(2) Weight per unit area and its maximum deviation;

(3) Ratio in weight of residual sheafing agents;

(4) Tensile strength of fibreglasses;

(5) Bending strength and modulus of bending elasticity obtained from laminated test specimens (in the standard condition);

(6) Tensile strength and modulus of tensile elasticity obtained from laminated test specimens (in the standard condition).

4 Roving for spray lay-up are to be tested and inspected on the items listed in the following (1) to (5):

(1) Appearance;

(2) Weight per unit area and its maximum deviation;

(3) Ratio in weight of residual sheafing agents;

(4) Bending strength and modulus of bending elasticity obtained from laminated test specimens (in the standard condition);

(5) Tensile strength and modulus of tensile elasticity obtained from laminated test specimens (in the standard condition).

4.3.2 Tests and Inspections of Resins for Laminating

The tests and inspections specified in 4.1.2 for resins for laminating to be used for hull structures of FRP ships are to be carried out on the items listed in the following (1) to (9). In this case, the procedures of tests and inspections are to be in accordance with the discretion of VR.

(1) Viscosity and thixotropy;

(2) Gel time, the minimum cure time and the peak exotherm temperature;

(3) Acid value;

(4) Water absorption rate of cats test specimens;

(5) Tensile elongation and tensile strength of cast test specimens;

(6) Load deflection temperature of cast test specimens;

(7) Barcol hardness obtained from laminated test specimens;

(8) Bending strength and modulus of bending elasticity obtained from laminated test specimens (in the standard condition);

(9) Tensile strength and modulus of bending elasticity obtained from laminated test specimens (in the standard condition).

4.3.3 Fillers

With regard to the fillers newly mixed with the FRP by the users in order to improve the properties such as abrasion resistance, fire resistance, etc. the data concerning the purpose for application, kind of filler, amount used, etc. are to be submitted to VR.

4.3.4 Sclerotics and Accelerators

The type and amount used of the sclerotics and accelerators are to be carefully selected so that they are suitable for resins for laminating and gelcoats and set in proper time without generating excessive local heat.

4.3.5 Tests and Inspections of Core Materials for Sandwich Construction

1 The tests and inspections specified in 4.1.2 of core materials for sandwich construction used for the hull structures of FRP ships are to be in accordance with the following -2 and -4. In this case, the procedures of tests and inspections are to be at the discretion of VR.

2 Hard plastic foams are to be tested and inspected on the items listed in the following (1) to (7):

(1) Specific gravity;

(2) Compressive strength and modules of compressive elasticity;

(3) Softening rate;

(4) Water absorption;

(5) Tensile strength and modulus of tensile elasticity (only in case where the cores are reckoned in tensile strength);

(6) Bending strength and modulus of bending elasticity (only in case where the cores are reckoned in bending strength);

(7) Shearing strength obtained from specimens of sandwich construction.

3 Cores of balsa are to be tested and inspected on the items listed in the following (1) to (3):

(1) Specific gravity and moisture content;

(2) Compressive strength and modulus of compressive elasticity in the direction of fibre;

(3) Shearing strength obtained from specimens of sandwich construction.

4 Timbers and plywoods are to be tested and inspected on the items in the following (1) to (4):

(1) Compressive strength and modules of compressive elasticity;

(2) Tensile strength and modulus of tensile elasticity (only in case where timbers of plywoods are reckoned in tensile strength);

(3) Bending strength and modules of bending elasticity (only in case where timbers or plywoods are reckoned in bending strength);

(4) Shearing strength obtained from specimens of sandwich construction.

4.3.6 Timbers and Plywoods for Primary Structures

1 Timbers and plywoods for primary structures are to be reasonably free from knots, shakes, decays and other defects, and to have the properties suitable for the purpose of application.

2 Timbers and plywoods for primary structures are to be well seasoned.

3 Plywoods for primary structures are to be plywoods for structures which are deemed appropriate by VR.

4.3.7 Cores for Moulding

1 Cores used for moulding in frames, longitudinals, etc., are to be of oil resistance, styren resistance and water resistance, and to have good adhesion to polyester resins.

2 Where the cores for moulding are reckoned in strength, tests are to be carried out on tensile strength and modulus of tensile elasticity or bending strength and modulus of bending elasticity. However, where sufficient data are submitted to and approved by VR, the above-mentioned tests may be dispensed with.

4.4 FRP

4.4.1 General

The material tests and strength tests of FRP used for hull construction of FRP ships (including FRP laminates and sandwich laminates) are to be in accordance with the requirements in this Chapter.

4.4.2 Tests and Inspections of FRP

FRP is to be tested in accordance with the requirements in 4.4.4 and 4.4.5 in the presence of the Surveyor.

4.4.3 Omission of FRP Material Tests and FRP Strength Tests

1 For a sister ship of others which were or are being built at the same workshop, the FRP material tests and FRP strength test may be omitted, notwithstanding the requirements in 4.4.2, provided that the raw materials used, manufacturing methods, inspection standards in the workshop, quality control system, etc. are examined and deemed appropriate by VR. However, for ships not less than 20 m in length, the FRP strength tests are not to be omitted.

2 The FRP for which omission of the material tests specified in **-**1 is applicable are such FRP that have been recognized by VR as being moulded by means of the same laminating and the same moulding procedures as those for the FRP having the certificates of FRP material tests in accordance with the requirements in 4.4.4.

4.4.4 FRP Material Tests

1 The FRP material tests are tests and inspections of FRP to be carried out prior to the commencement of moulding of FRP ships.

2 The test specimens for FRP material tests are to be cut form FRP which are of the same laminate composition (excluding gelcoats) and moulded by the same procedure and at the same workshop as the actual hull laminates. The test specimens are to be tested and inspected on the items listed in the following (1) and (2). The procedures of tests and inspections are to be in accordance with the discretion of VR:

(1) FRP laminates (including FRP laminates of inner layer and outer layer of sandwich laminates);

(a) Thickness of moulding;

(b) Barcol hardness;

(c) Glass content (ratio in weight);

(d) Bending strength;

(e) Modulus of bending elasticity;

(f) Tensile strength;

(g) Modulus of tensile elasticity.

(2) Sandwich laminates

(a) Thickness of moulding of sandwich laminates;

(b) Tensile strength of sandwich laminates, only in case where the cores are reckoned in the tensile strength. In this case, the test specimens in which joints of cores are involved are to be included;

(c) Shearing strength of sandwich laminates. In case where the cores are reckoned in the bending strength, the test specimens in which joints of cores are involved are to be included

3 The FRP material tests are to be carried out, at least on the structural members listed in the following (1) to (4). The FRP material tests on the other members are to be carried out only in case where scantlings are modified in accordance with the requirements in 1.3.4-2.

(1) Bottom shell laminates;

(2) Side shell laminates;

(3) Upper deck laminates;

(4) Bulkhead (only of sandwich construction).

4 The results of FRP material tests containing the items listed in the following (1) to (10) are to be submitted to VR:

(1) Names of fibreglass reinforcements, resins for laminating and cores for sandwich construction;

(2) Names and amount of application of fillers;

(3) Names and amount of application of sclerotics and accelerators;

(4) Procedures and conditions of moulding;

(5) Direction of selection of test specimens;

(6) Dates of moulding and tests of test specimens;

(7) Place of tests and environmental condition of the site of tests;

(8) Types of testing machines;

(9) Form and dimensions of test specimens;

(10) Test results.

5 The number of test specimens subjected to the FRP material tests are to be five, unless specially specified, and the arithmetical mean of the smaller three values obtained from the five specimens is to be taken as the test result.

6 The result of FRP material tests is not to be less than the strength specified in1.3.4 for FRP laminates and not to be less than the value obtained from the tests specified in 4.2.1 or 4.3.5 for sandwich laminates.

4.4.5 FRP Strength Tests

1 The FRP strength tests are tests and inspections to be carried out after the completion of FRP ships.

2 The test specimens which are to be cut from the laminates and sandwich laminates taken from the actual hull laminates or the laminates and sandwich laminates equivalent thereto, are to undergo tests and inspections on the items specified in 4.4.4-2 and -3. And further, the testing procedure and location of selection of test specimens are to be at the discretion of VR.

3 The results of FRP strength tests are to be submitted to VR as the results of FRP strength tests containing the items specified in 4.4.4-4 and the location of selection of test specimens.

4 The number of test specimens for FRP strength tests and the determination of test results are to be in accordance with the provisions in 4.4.4-5.

5 Where the results of FRP strength tests are less than those of FRP material tests in 4.4.4, the structural members are to be properly strengthened.

CHAPTER 5 MOULDING

5.1 General

5.1.1 Application

The requirements in this Chapter are framed for the case where FRP is moulded by the hand lay-up method or spray lay-up method. The moulding methods other than those mentioned above are to be in accordance with the discretion of VR.

5.1.2 Supervision over Moulding

Moulding of FRP is to be carried out under the supervision of a well-experienced techinical expert.

5.1.3 Curing of Mouldings

Mouldings which are deemed not to have been fully cured are not to be kept under the environmental condition which may prevent them from effective curing. And, post curing of moulding at high temperature, if intended, is to be approved by VR.

5.1.4 Supporting of Moulding

After released from the mould, the mouldings are to be supported by proper means.

5.1.5 Blending Proportion

The blending proportion between curing agents and accelerators is to be determined suitable for obtaining FRP of good quality, in consideration of the environmental conditions of laminating shops, such as temperature, relative humidity, etc. and also the pot life and mat life resins.

5.1.6 Operation Manual

1 Before moulding, examinations are to be made in detail with respect to the items listed in the following (1) to (4) and moulding is to be proceeded on the basis of such examinations:

(1) Environmental conditions, controlling system thereof, pot life and curing time of resins;

(2) Operation procedure, scheduled operation process and working hours;

(3) Kinds, cutting methods, overlap of joints, edge preparation and number of plies of fibreglass reinforcements;

(4) Kinds, amount, blending quantity at one time and blending procedures of resins used.

5.1.7 Environmental Conditions of Laminating Shops

1 The temperature while laminating is to be kept suitable for the resins used. The temperature is, however, not to be lower than 15 °C.

2 The humidity while laminating is preferable to be not lower than 60% but not higher than 80%.

3 Dusts, rubbishes and detrimental fumes in the laminating shops are to be cleared off as far as practicable.

5.1.8 Gelcoats

1 Gelcoat resins are to be evenly coated or sprayed.

2 The standard thickness of gelcoat film is approximately 0.5 mm.

5.1.9 Moulding of Structural Members

It is recommended that the structural members are moulding in one body with the prescribed hull laminates before they advance in cure. However, structural members separately moulding may be bonded to the hull laminates.

5.1.10 Sanding

Where the outer surface of FRP laminates is sanded, attention is to be paid lest the fibreglasses on the sanded surface should be heavily damaged.

5.1.11 Cut Edges of Laminates

The cut edges of laminates, holes for bolts, etc. are to be thoroughly covered with resin so that the fiberglass reinforcements are not exposed.

5.1.12 Mould Releasing

1 Mould releasing operation is to be carefully carried out lest permanent deformations and damages harmful to the hull laminates should be caused.

2 After releasing, the hull laminates are to be supported by an area as wide as practicable so that they are subjected to a uniform load.

5.2 Hand Lay-up Method

5.2.1 Seams of Fibreglass Reinforcements

Fibreglass reinforcements are to be arranged so as to have seams of reinforcements as few as practicable. The overlap at seams is not to be less than 50 mm. The centre lines of overlaps of two adjacent plies are not be less than 100 mm apart from each other so far as no obstruction exists for the work.

5.2.2 Degassing

In laminating, after having the fibreglass reinforcements thoroughly impregnated with resin, air bubbles in the resin are to be removed by degassing rollers or rubber pallets. However, excessive squeezing of resins is not desirable and care is to be taken to keep the glass content proper.

5.2.3 Glass Content

1 In laminating, the standard glass content (ratio in weight) is approximately 30% in case of chopped mats or approximately 50% in case of roving cloths, and laminating is to be carried out uniformly to avoid local excess or scarcity of resin.

2 The aggregated weight of roving cloths is to be 25% to 65% of the total weight of glass. Where, however, special fibreglass reinforcements are used, the weight is to be in accordance with the discretion of VR.

5.2.4 Laminating

Where the successive laminating is interrupted in such a case of laminating thick shell plating, etc., non-paraffin resins are to be used for the first of any subsequent layers of

reinforcement to be laid in that area and care is to be taken not to leave over the excessive resin layer.

5.2.5 Laminating for Final Ply

As for laminating for the final ply, effective measures to cure the outer surface are to be provided.

5.3 Spray Lay-up Method

5.3.1 Spray Lay-up Apparatus

1 The spray lay-up apparatus is to be approved by VR.

2 The spray lay-up apparatus is to be those which can mould FRP so that the glass content, mechanical properties, etc., are uniform.

3 Moulding by means of the spray lay-up apparatus is to be carried out by skilled moulding operators.

5.3.2 Moulding of Primary Structural Members

Where the chopped mat parts of the primary structural members of hull are moulded by means of the spray lay-up method, the method is to be approved by VR.

5.4 Moulding of Sandwich Construction

5.4.1 Cores

1 Where the cores which are composed of hard plastic foams are temporarily set by nails, care is to be taken to ensure that the cores are free from dent, misalignment and other defects due to nailing. And, no penetrating clearance not less than 1 mm is to be left between the cores.

2 Where balsas are used for cores, care is to be taken to have the balsas thoroughly impregnated with resins. The clearance between the balsas is, as a rule, not to be more than 4 mm.

5.4.2 Surface Treatment of Cores

In moulding of sandwich construction, the surface of cores is to be properly treated in order to obtain sufficient bonded connection between the FRP layer and the core.

5.5 Bonding and Fastening

5.5.1 Bonding

1 Bonding is to be executed after making effective preparation such as sanding the surface to be bonded and thoroughly removing oils and sanding dusts.

2 Bonding is to be executed paying careful attention not to cause spring back of fibreglass reinforcements.

3 Bonding is to be carefully executed so as not to cause any deformation due to excessive exothermic effect.

4 Bonding is to be carefully carried out so as not to cause strength discontinuity at the joint.

5 T-joints and L-joints are to be laminated at the site.

5.5.2 Fastening

1 Where laminates are connected each other or where metallic fittings are fastened to laminates, mechanical fastening may be applied. In this case, the fasteners such as bolts, rivets, screws, etc. are to be sea-water-corrosion-resistant metal or to be properly protected against corrosion.

2 Mechanical fastening is to be carried out at a right angle to the laminates as far as practicable and the fastening holes are to be well coated with resins.

5.5.3 Bolts

1 The distance between the centre of bolt hole and the edge of laminate is not to be less than three times the diameter of the hole. The distance between the bolt holes is not to be less than three times diameter of the hole.

2 Where bolts are used, washers are to be used on the surface of laminate.

5.5.4 Connection of Sandwich Laminates

Where bolts, screw, rivets, etc., are used, penetrating sandwich laminates with cores of hard plastic foams, timbers or plywoods well seasoned are to be inserted in such parts of the cores in advance.

5.5.5 Watertight Construction

Where mechanical fastening such as bolted joints, etc. is used in way of a location where watertightness is required, suitable measures are to be provided to maintain watertightness.

5.6 Bonded Connections

5.6.1 T-joints

1 The overlap width of T-joints of structural members are generally to be in accordance with Fig. 5.1.

2 In T-joints of members of sandwich construction, the aggregated thickness of the inner laminate and the outer laminate of FRP may be used as the thickness (t) shown in Fig. 5.1.

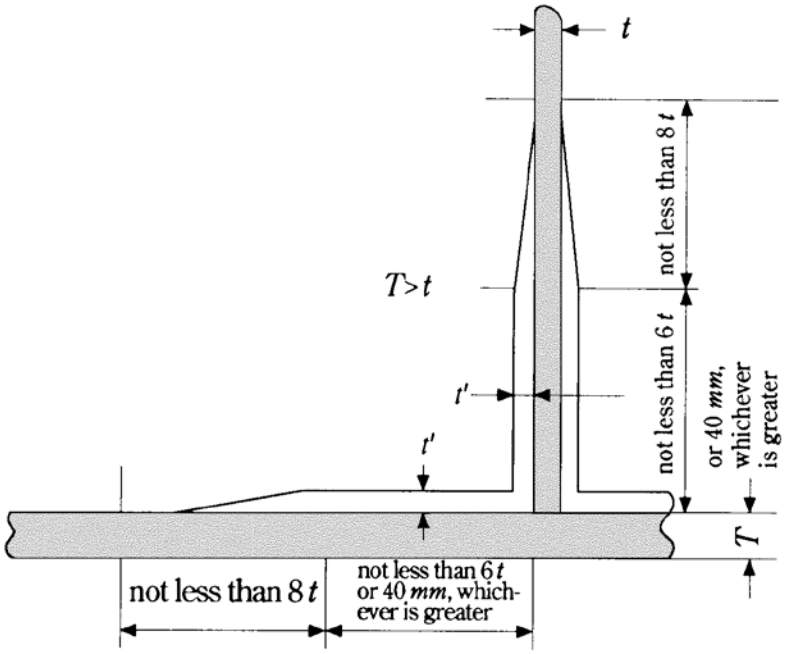
3 The form of laminating of T-joints is to be as shown in Fig. 5.2(a) and Fig. 5.2(b).

4 Where the members such as engine girders, bulkheads, etc., which are subjected to considerably heavy load or vibration are connected, careful considerations are to be given in such a manner as to arrange structural members upon the laminates which are increased in thickness as shown in Fig. 5.3(a).

5 Where the members other than those specified in the preceding (4), that is, the members which are not deemed subjected to specially heavy load or vibration, are connected to the structural members, plastic foams or other similar materials are to be inserted between the member and the laminate as shown in Fig. 5.3(b) or the corners are to be sufficiently laminated by filling with soft resin puttys or other similar materials as shown in Fig. 5.3(c).

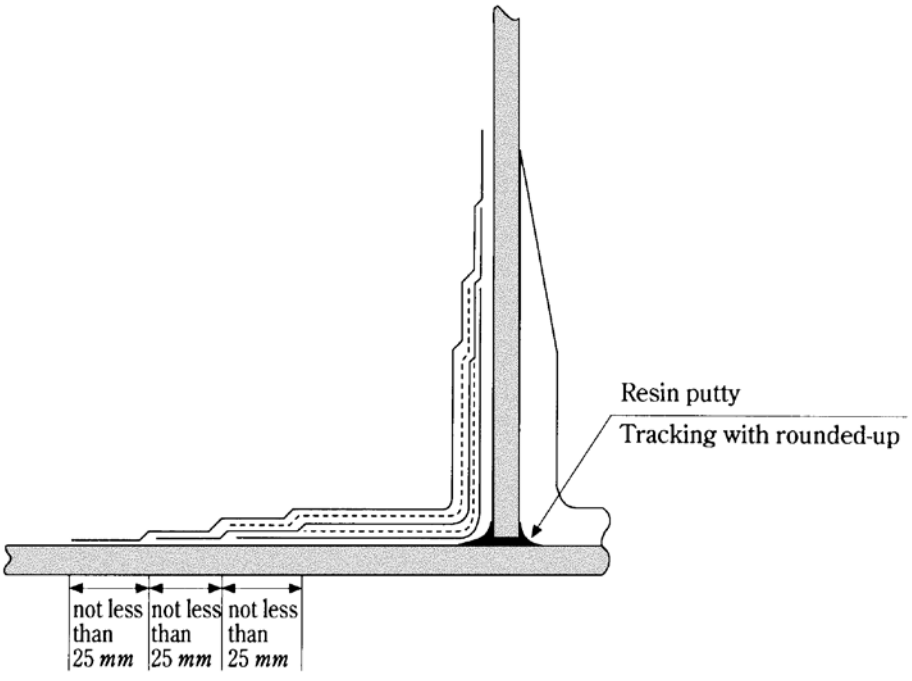
5.6.2 L-joints

L-joints are generally not to be used for primary structural members. Where, however, L-joints are inevitably used because adoption of T-joints is difficult, careful consideration is to be paid to the construction of the joints.



t' is thickness of overlap but not to be less than $t/2$.

Fig. 5.1 Dimensions of Overlap of T-joints



(a) Solid lines indicate chopped mat layers and dotted lines indicate roving cloth layers.
(b) Roving cloth layers are not to overlap each other.
(c) The first and final layers are to be a chopped mat layer.

Fig. 5.2(a) In Case Chopped Mats and Roving Cloths are jointly Used

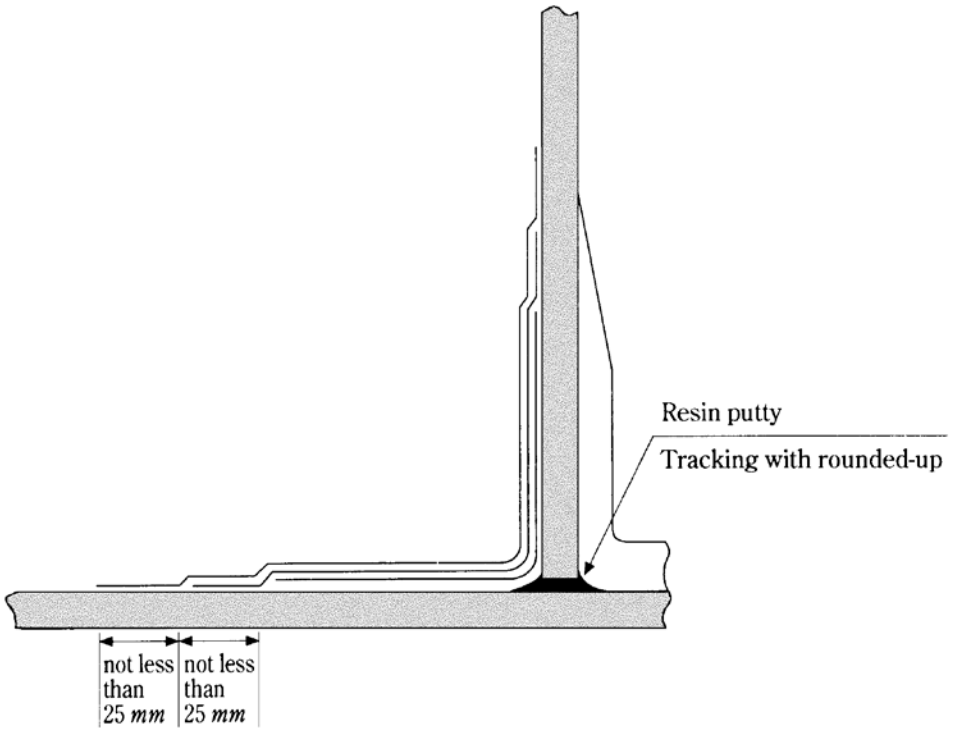


Fig. 5.2(b) In Case Chopped Mats are Used

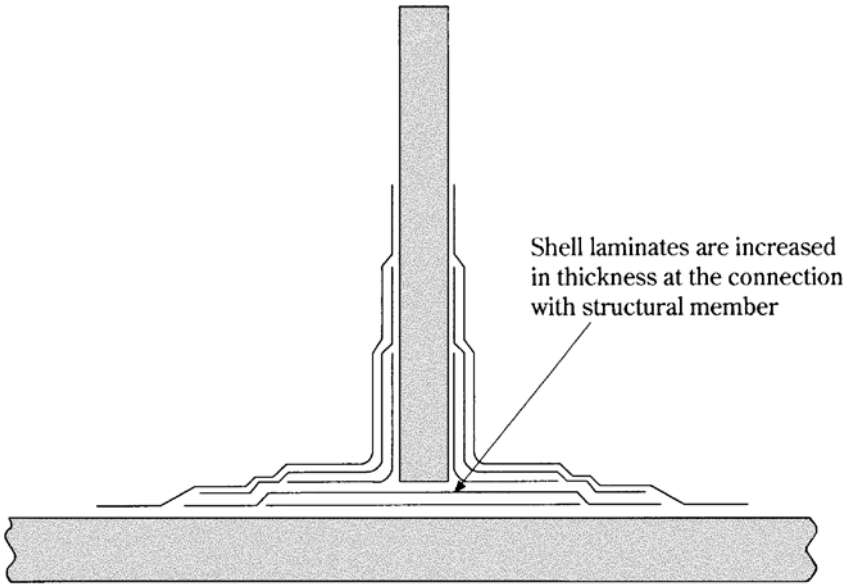


Fig. 5.3(a) In Case Consideration is to be Paid to Load or Vibration

5.6.3 Butt Joints

1 In the shell laminates, butt joints are not to be provided. However, in case of repair, etc., where joints are locally provided, scarph joints may be used.

2 In the butt joints of deck laminates, joints other than scarph joints of V-type or X-type are not to be used.

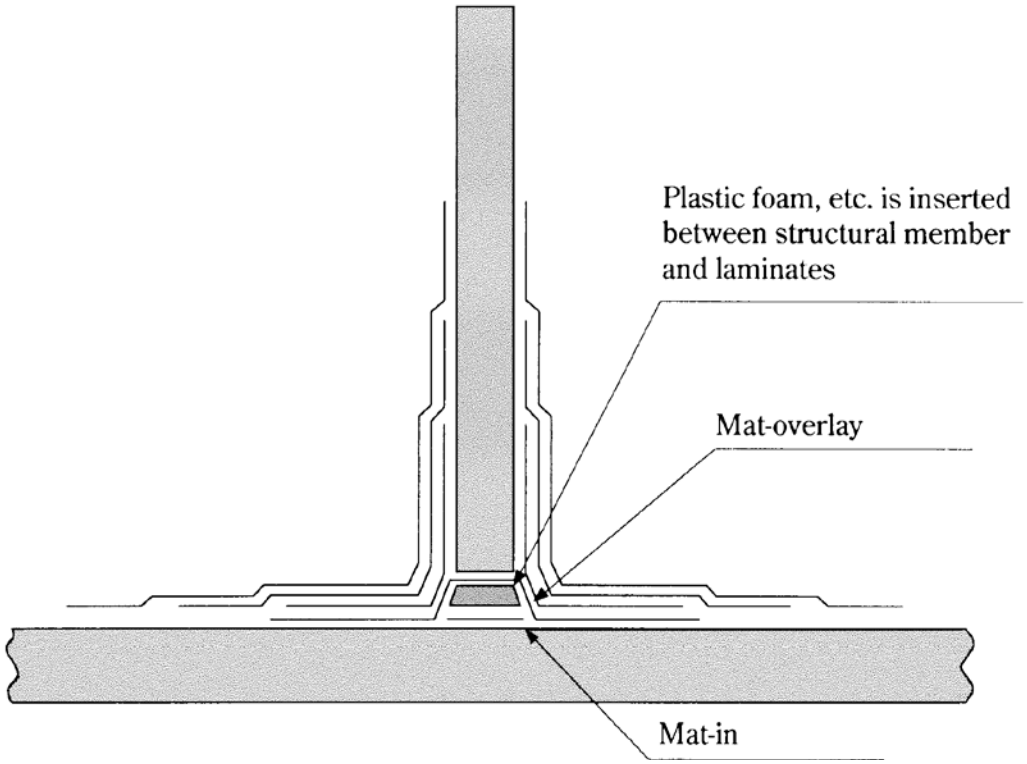


Fig. 5.3(b) Standard Form of T-joints

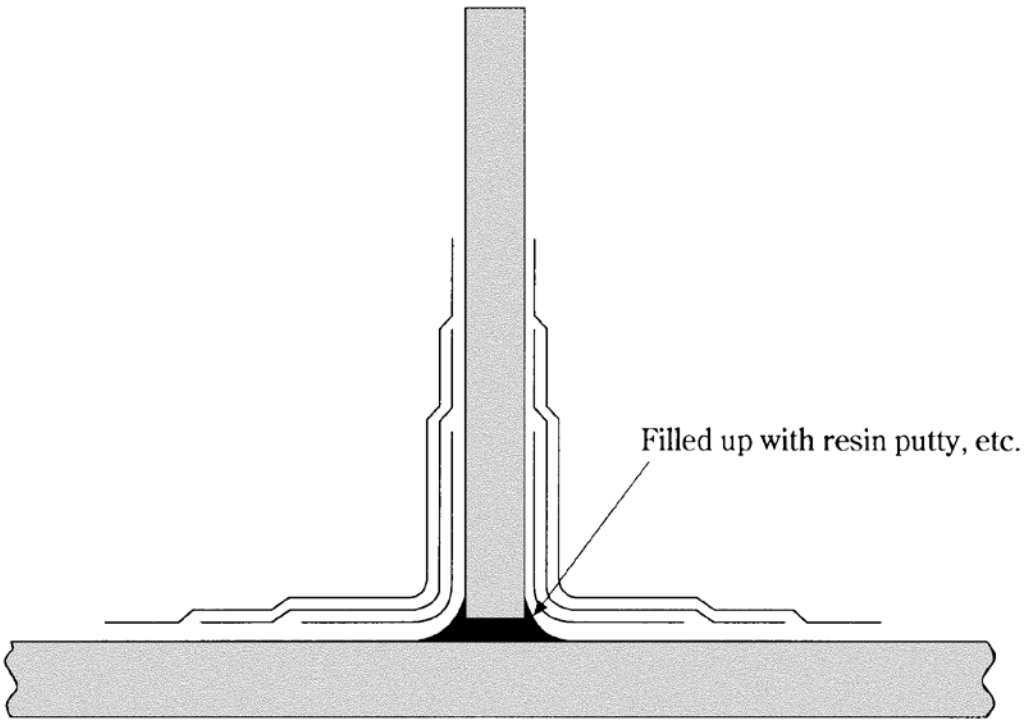


Fig. 5.3(c) Standard Form of T-joints

CHAPTER 6 LONGITUDINAL STRENGTH

6.1 Longitudinal Strength

6.1.1 Section Modulus of Athwartship Section

The section modulus of the hull for midship part is not to be less than obtained from the following formula:

$CL^2B_w(C_b + 0.7)$ (cm^3)

Where:

C: Coefficient obtained from the following formula. In no case, however, is it to be less than 44.

0.4L + 36

B_w: Horizontal distance between the outside of side shell laminates at the designed maximum load line (m);

C_b: Volume of displacement at the designed maximum load line divided by LB_wd.

6.1.2 Moment of Inertia of Athwartship Section

The moment of inertia of the athwartship section for midship part is not to be less than obtained from the following formula:

$4.2ZL$ (cm^4)

Where:

Z: Section modulus of the athwartship section specified in 6.1.1 (cm^3).

Where, however, L/D for FRP ships of single bottom is less than 12.0, the calculation of the moment of inertia may be dispensed with.

6.1.3 Calculation of Section Modulus of Athwartship Section

1 The calculation of section modulus of the athwartship section is to be in a accordance with the requirement in the following (1) to (4):

(1) Longitudinal members below the strength deck which are considered as continuous for 0.5L amidships are to be included in the calculation. Longitudinal members above the strength deck which are considered effective to the longitudinal strength of the ship may be included in the calculation.

(2) The section modulus at the strength deck is the moment of inertia about the horizontal neutral axis of the athwartship section divided by the vertical distance from the neutral axis to the top of strength deck beam at side, or to the top of the longitudinal members above the strength deck in case where such members are included in the calculation in accordance with the provisions in (1). The section modulus at the bottom is the above-mentioned moment of inertia divided by the vertical distance from the neutral axis to the base point of D, or to the bottom of keel in case where the keel is of hat-type construction.

(3) Timbers or structural plywoods are to be included in the calculation multiplying the sectional area by the ratio of the modulus of tensile elasticity of the relevant material to that of the FRP.

(4) Where cores of sandwich laminates or cores for moulding are included in the longitudinal strength, the sectional area multiplied by the ratio of the modulus of tensile elasticity of the relevant core to that of the FRP is to be included in the calculation. Where a joint of the core exists for 0.5L amidships, sufficient data with respect to the longitudinal strength and joints are to be submitted to VR for approval.

6.1.4 Continuity of Strength

Longitudinal strength members are to be of such a construction as to maintain good continuity of strength.

CHAPTER 7 SHELL LAMINATES

7.1 General

7.1.1 Application

The scantlings of shell laminates specified in this Chapter are applied for the case where the shell is of single skin construction or of sandwich construction.

7.2 Keels

7.2.1 Construction and Scantlings

1 Keels are to be as continuous from fore end to after end as practicable.

2 The breadth or girth length and thickness of keel laminates over the whole length of the ship are not to be less than obtained from the following formula. In no case, however, is the thickness to be less than that of the adjacent bottom shell laminates. And, the breadth or girth length need not exceed 0.2 times B.

Breadth or girth length: 530 + 14.6L (mm)

Thickness: 9 + 0.4L (mm)

7.3 Shell Laminates for Midship Part

7.3.1 Side Shell Laminates of Single Skin Construction

The thickness of side shell laminates of single skin construction is not to be less than obtained from the following formula:

$15S\sqrt{d+0.026L}$ (mm)

Where:

S: Spacing of frames (m).

7.3.2 Bottom Shell Laminates of Single Skin Construction

The thickness of bottom shell laminates of single skin construction is not to be less than obtained from the following formula:

$15.8S\sqrt{d+0.026L}$ (mm)

Where:

S: Spacing of frames (m).

7.3.3 Shell Laminates of Sandwich Construction

1 The aggregated thickness of inner layer, outer layer and core of sandwich construction is not to be less than obtained from the following formulae, whichever is greater:

$C_1S(d+0.026L)$ (mm)

C_2t_f (mm)

Where:

t_f : Thickness in case of single skin construction specified in 7.3.1 or 7.3.2 (mm);

S: Spacing of frames (m);

C_1: Coefficient obtained from the following formula: $\frac{10C_3}{\tau_a}$

τ_a: Shearing strength of sandwich laminates obtained from the test specified in 4.2.1 or 4.3.5-2(7), -3(3) or -4(4) (N/mm^2);

C_2 and C_3: As given in Table 7.1. For the intermediate values of a and b, C_2 and C_3 are to be obtained by linear interpolation.

Table 7.1 Values of C_2 and C_3

β		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
C2	α = 0.8	1.62	1.42	1.31	1.24	1.20	1.16	1.14	1.12	1.10
	α = 1.0	1.54	1.36	1.25	1.19	1.15	1.12	1.10	1.08	1.07
C_3		2.18	2.26	2.33	2.40	2.46	2.52	2.57	2.62	2.67

Where:

α: The thickness of outer layer or inner layer of FRP, whichever is the divided by the greater thickness;

β: The sum of the thickness of outer layer and inner layer of FRP divided by the thickness of core.

2 The respective thickness of inner layer and outer layer of shell laminate of sandwich construction is not, notwithstanding the requirements in the preceding -1, to be less than obtained from the following formula. In no case, however, is it to be less than 2.4 mm:

$$3.6\sqrt[3]{C_4 S^4 (d + 0.026L)^4} \quad \text{(mm)}$$

Where:

S: Space of frames (m);

C_4: Coefficient obtained from the following formula:

$$C_4 = \frac{1}{t_c}\frac{E_c}{E_f}\left(\frac{10}{\sigma_c}\right)^4$$

E_f: Modulus of bending elasticity of inner layer or outer layer specified in 1.3.4 (N/mm^2);

E_c: Modulus of compressive elasticity of core obtained from the test specified in 4.2.1, 4.3.5-2(2), -3(2) or -4(1) (N/mm^2);

σ_c: Compressive strength of core obtained from the test specified in 4.2.1, 4.3.5-2 (2), -3 (2) or -4(1) (N/mm^2);

t_c: Thickness of core (mm).

7.4 Shell Laminates for End Parts

7.4.1 Thickness of Shell Laminates for End Parts

1 The thickness of shell laminates of single skin construction may be gradually reduced beyond the midship part and it may be 0.85 times the thickness of shell laminates amidships for end parts.

2 Shell laminates of sandwich construction beyond the midship part are to be of the same construction as that for the midship part.

3 For the part where subjected to local loads such as propeller pressure, etc., the shell laminates are to be properly strengthened.

7.4.2 Strengthened Bottom Forward

1 The strengthened bottom forward is the part of flat bottom forward from the position specified in the following (1) to (2). The flat bottom is the bottom whose slope measured at the respective athwartship sections (See Fig. 7.1) is not more than 15^{o}.

(1) Where $V/\sqrt{L}$ is not more than 1.5: 0.25L from the fore end;

(2) Where $V/\sqrt{L}$ exceeds 1.5: 0.30L from the fore end.

Where V is the designed speed in knots which the ship with clean bottom can attain at the maximum continuous output on calm sea in loading condition corresponding to the designed maximum load line (hereinafter referred to as the full load condition in the Regulation).

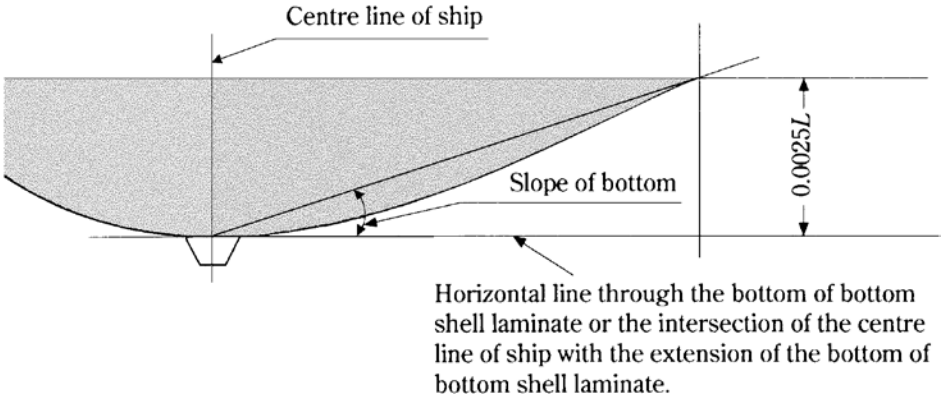


Fig. 7.1 Slope of Bottom

7.4.3 Shell Laminates at the Strengthened Bottom Forward

1 The thickness of shell laminates at the strengthened bottom forward of single skin construction is not to be less than obtained from the following formula:

$CS\sqrt{L}$ (mm)

Where:

C: Coefficient given in Table 7.2. However, for the intermediate value of α, is to be obtained by linear interpolation;

S: Spacing of frames, or spacing of girders or longitudinal shell stiffeners, whichever is smaller (m);

α: Spacing of frames, or spacing of girders or longitudinal shell stiffeners, whichever is greater (m), divided by S.

Table 7.2 Values of C

α	1.0	1.2	1.4	1.6	1.8	$\geq$ 2.0
C	5.36	5.98	6.37	6.62	6.75	6.81

2 The thickness of shell laminates at strengthened bottom forward of sandwich construction is not to be less than obtained from the formula specified in 7.3.3-1. However, in application of the formula, C_3 is to be taken as 1.8 times that given in Table 7.1 and t_f as the thickness of shell laminates specified in 7.3.3-1.

3 In FRP Ships whose L is less than 20 m and V is less than 14 knots or in FRP Ships which are deemed by VR to have sufficient bow draught, the thickness specified in the preceding -1 and -2 may be properly reduced.

7.5 Side Shell Laminates in way of Superstructures

7.5.1 Thickness of Shell Laminates

1 The side shell laminates in way of superstructures are to be in accordance with the requirements in the following (1) to (2):

(1) The thickness of side shell laminates in way of superstructures for 0.25L from the fore end and that of side shell laminates in way of sunken forecastle or sunken poop is not to be less than that of side shell laminates at the place;

(2) The thickness of side shell laminates in way of superstructures other than specified in the preceding (1) may be 0.8 times that of side shell laminates at the place.

7.6 Local Strengthening of Shell Laminates

7.6.1 Strengthening of Shell Laminates Fitted with Hawse Pipes and Adjacent Shell Laminates

The side laminates and others which are in danger of contact with anchors and chain cables, etc. are to be properly strengthened.

CHAPTER 8 DECKS

8.1 General

8.1.1 Application

1 The requirements in this Chapter are framed for the construction and scantlings of decks moulded with FRP. The decks such as wooden decks which are composed of other materials than FRP are to be in accordance with the discretion of VR.

2 The construction and scantlings of decks specified in this Chapter are applied for the case where decks are of single skin construction or of sandwich construction.

8.1.2 Watertightness of Decks

Decks are to be made watertight construction except where specially approved by VR.

8.1.3 Continuity of Decks

Where upper decks change in level, the change is to be accomplished by gradually sloping the decks, or each of structural members which form decks is to be extended and to be effectively connected together by suitable means.

8.2 Minimum Thickness of Deck Laminates

8.2.1 Thickness of Deck Laminates of Single Skin Construction

1 The thickness of upper deck laminates for midship part in case where longitudinally framed, is not to be less than obtained from the following formula:

$4.8S\sqrt{h}$ (mm)

Where:

S: Spacing of longitudinal beams (m);

h: As specified in 8.2.3 (kN/m^2).

2 The thickness of upper deck laminates for midship part in case where transversely framed, is not to be less than obtained from the following formula:

$5.81S\sqrt{h}$ (mm)

Where:

S: Spacing of longitudinal beams (m);

h: As specified in 8.2.3 (kN/m^2).

3 The thickness of upper deck laminates except for midship part and that of other deck laminates are not to be less than obtained from the following formula:

$4.2S\sqrt{h}$ (mm)

Where:

S: Spacing of longitudinal beams or transverse beams (m);

h: As specified in 8.2.3 (kN/m^2).

8.2.2 Thickness of Deck Laminates of Sandwich Construction

1 The aggregated thickness of inner laminates, outer laminates and cores of sandwich construction is not to be less than obtained from the following formulae, whichever is greater:

$0.1C_1Sh$ (mm)

C_2t_f (mm)

Where:

S: Spacing of longitudinal beams of transverse beams (m);

h: As specified in 8.2.3 (kN/m^2);

t_f: Thickness of deck laminates in case of single skin construction specified in 8.2.1 (mm);

C_1 and C_2: As specified in 7.3.3-1.

2 The respective thickness of the inner laminates and outer laminates of decks of sandwich construction are not, notwithstanding the requirements in the preceding -1, to be less than obtained from the following formulae. In no case, however, is it to be less than 2.4 mm.

$0.17\sqrt[3]{C_4(Sh)^4}$ (mm)

Where:

S: Spacing of longitudinal beams of transverse beams (m);

h: As specified in 8.2.3 (kN/m^2);

C_4: As specified in 7.3.3-2.

8.2.3 Deck Load h

1 Deck load h for decks intended to carry cargoes, etc. is to be as specified in the following (1) to (3):

(1) For decks intended to carry cargoes and stores, h is to be 7 times the tween deck height at side in metres from the deck to the deck immediately above it (kN/m^2),or cargo weight per unit area of the deck (kN/m^2),whichever is greater;

(2) Where cargoes are intended to be carried on the weather deck, h is to be cargo weight per unit area of the deck (kN/m^2) or the value stipulated in -3, whichever is greater;

(3) For decks intended to carry cargoes whose weight is considerably light, h may be suitably modified.

2 For decks exclusively used for accommodation or navigation spaces and for tops of long deckhouses, h is to be 4.5 (kN/m^2).

3 For weather decks, h is to be as specified in the following (1) and (2):

(1) For weather decks afore 0.3L from the fore end:

$0.5L + 4.5$ (kN/m^2);

(2) For weather decks abaft 0.3L from the fore end:

$0.26L + 4.5$ (kN/m^2).

8.3 Local Compensation of Decks

8.3.1 Compensation for Large Openings

1 Deck laminates in way of corners of large openings are to be suitably increased in thickness.

2 Corners of openings are to be suitably rounded.

8.3.2 Location of Openings

The distance between the ship side or hatch side and the opening is not to be less than 1.5 times the diameter of the opening. Where, however, the distance is necessary made less than this value, suitable compensation is to be provided.

8.3.3 Decks in Danger of Abrasion

Deck laminates which are in danger of abrasion due to heavy loads, etc. are to be suitably protected from abrasion by means of increasing thickness or coverings.

8.3.4 Decks Carrying Heavy Loads

Parts of deck laminates where heavy loads such as deck machinery and others are carried are to be increased in thickness or to be suitably strengthened.

CHAPTER 9 FRAMES

9.1 General

9.1.1 Application

1 The requirements in this Chapter are framed for the construction and scantlings of frames moulded with FRP.

2 For FRP ships with especially long holds or with especially large hatch openings, the transverse stiffness of the hull is to be suitable increased by increasing the scantlings of frames or by providing web frames additionally.

9.1.2 Frames in way of Deep Tanks

The strength of frames in way of deep tanks is not to be less than required for stiffeners on deep tank bulkheads.

9.2 Construction

9.2.1 Construction of Frames

1 Frames are so constructed as to avoid lateral buckling.

2 Where the length of ship is small, corrugated side shell laminates may be adopted in lieu of normal framing construction.

9.2.2 Cores for Frames

1 Timbers used for cores are to be well seasoned and free from sapwood. Care is to be taken lest the timbers wrapped in FRP should cause dry rot.

2 Plastic foams used for cores are to be non-hygroscopic.

9.3 Spacing of Frames

9.3.1 Spacing of Frames

1 The standard spacing of frames is 500 mm.

2 The spacing of frames afore 0.2L from the fore end and in the aft peak is not to exceed 500 mm.

9.3.2 Consideration for Especially Large Frame Spacing

Where the spacing of frames is 750 mm or over, special considerations are to be given to the construction and scantlings of the primary hull structural members.

9.4 Frames

9.4.1 Scantlings of Transverse Frames

1 The section modulus of transverse frames abaft 0.15L from the fore end is not to be less than obtained from the following formula:

$$32Shl^2 \qquad (cm^3)$$

Where:

S: Spacing of frames (m);

l: Vertical distance from the top of inner bottom laminates or single bottom floor at side to the top of upper deck beams at side (m). For frames abaft 0.25L from the fore end, L is to be measured at midship. For frames between 0.25L and 0.15L from the fore end, l is to be measured at 0.25L from the fore end;

h: Vertical distance from the lower end of l at the place of measurement to a point d +0.026L (m) above the base point of D (m). Where, however, the distance is less than 0.5D (m), h is to be taken as 0.5D (m).

2 The section modulus of transverse frames afore 0.15L from the fore end is not to be less than obtained from the following formula:

$37.5Shl^2 \quad (cm^3)$

Where:

S, h and l: As specified in the preceding -1. However, l is to be measured at 0.15L from the fore end.

9.4.2 Side Longitudinals

1 The section modulus of side longitudinals below the upper deck for the midship part is not to be less than obtained from the following formula:

$49Shl^2 \quad (cm^3)$

Where:

S: Spacing of longitudinals (m);

h: Vertical distance from the longitudinals to a point d +0.026L (m) above the base point of D (m). Where, however, the distance is less than 0.5D (m), h is to be taken as 0.5D (m);

l: Distance between the transverse bulkheads, or where web frames are provided, distance between the web frames or between the transverse bulkhead and web frame including the length of end connection (m).

2 Beyond the midship part, the section modulus of side longitudinals may be gradually reduced toward the ends of ship, and may be 0.85 times that obtained from the formula in the preceding -1 for the end parts, However, the section modulus of side longitudinals afore 0.15L from the fore end is not to be less than obtained from the formula in the preceding -1.

9.4.3 Web Frames Supporting Side Longitudinals

Where the ship's side is longitudinally flamed, web frames supporting side longitudinals are to be provided in a spacing not exceeding about 2.4 m. However, the construction and scantlings thereof are to be in accordance with the discretion of VR.

9.4.4 Hat-type Construction

With respect to the scantlings of frames of hat-type construction, the requirements in 1.3.5, in addition to the requirements in this Chapter, are to be applied.

CHAPTER 10 BOTTOM CONSTRUCTION

10.1 General

10.1.1 Application

1 The requirements is this Chapter are framed mainly for the single bottoms.

2 Where bottom are partially or wholly of double bottom construction, the double bottoms are to be in accordance with the requirements on 10.6, and, in addition, the structural members of double bottoms are to be constructed with special care.

10.2 Centre Girders

10.2.1 Construction and Scantlings

1 Centre girders are to extend from the collision bulkhead to the aft peak bulkhead as far as practicable.

2 The thickness of web of centre girders is not to be less than obtained from the following formula. However, beyond the midship part, the thickness may be gradually reduced toward the ends and to may be 0.85 times the midship value for the end parts:

0.4L + 4.7 (mm).

3 The breadth and thickness of the face plates are not to be less than obtained from the following formulae respectively. However, beyond the midship part, the sectional area of the face plates may be gradually reduced toward the ends and it may be 0.8 times the midship value of the end parts.

Thickness: 0.4L + 4.7 (mm);

Breadth: 4L + 30 (mm).

4 The webs of centre girders are to extend to the top of floors of bottom transverse girders.

5 In the engine room, the thickness of webs and face plates of centre girders are not to be less than 1.25 times the values specified in the preceding **-**2 and -3, respectively.

6 For ships with hat-type keel of suitable height, the centre girder may be omitted.

10.3 Side Girders

10.3.1 Arrangement of Side Girders

Where the breadth of ship measured at the top of floors exceeds 4 m, side girders are to be arranged at a suitable spacing.

10.3.2 Construction and Scantlings

1 The thickness of webs of side girders for the midship part is not to be less than obtained from the following formula. However, beyond the midship part, the thickness may be gradually reduced toward the ends and it may be 0.85 times the midship value at the end parts.

0.3L + 3.5 (mm).

2 The thickness of face plates of side girders is not to be less than the thickness of webs and the breadth is not to be less than obtained from the following formula. However,

bayond the midship part, the sectional area may be gradually reduced toward the ends and it may be 0.8 times the midship value at the end parts.

3.2L + 24 (mm).

3 The heights of side girders at their ends are to extend to the top of floors or bottom transverse girders.

10.3.3 Side Girders in Engine Room

The thickness of webs and face plates of side girders in the engine room are not to be less than the thickness of webs and face plates of centre girders specified in 10.2.1-2 and -3, respectively.

10.4 Floors

10.4.1 Arrangement and Scantlings

1 Where transverse framing is adopted in the bottom construction, floors are to be fitted at every frame and the scantlings of floors are not to be less than obtained from the following formula. In no case, however, is the thickness of floor plates to be less than 4 mm.

Depth of floor plates at the centre line of ship: 62.5b (mm)

Where:

b: Horizontal distance between the outer surfaces of the side shell laminates measured on the upper surface of the floor (m).

Thickness of floor plates: 0.4L (mm).

2 Beyond 0.5L amidships, the thickness of floor plates may be gradually reduced toward the ends and it may be 0.9 times the value specified in the preceding **-**1 at the end parts. However, the floors in the strengthened bottom forward are to be in accordance with the requirements in 10.7.2.

3 Floors under main engines and thrust blocks are to be of sufficient depth and to be of specially substantial construction. The thickness is not to be less than that of webs of centre girders obtained from the formula in 10.2.1-2.

10.4.2 Section Modulus of Floors

1 The thickness of face plate provided on the upper edges of floors is not to be less than the thickness of web of floor at the place.

2 The section modulus of floors is not to be less than obtained from the following formula:

$15.4SDb^2$ (cm^3)

Where:

S: Spacing of floors (m);

b: As specified in 10.4.1-1.

3 The section modulus of floors under the main engine seatings is not to be less than 1.5 times the value specified in the preceding -2.

10.4.3 Floor Plates Forming Part of Bulkheads

Floor plates forming part of bulkheads are to be in accordance with the requirements for watertight bulkheads in Chapter 13 and those for deep tanks in Chapter 14 in addition to those in this Chapter.

10.5 Bottom Longitudinals, etc.

10.5.1 Construction

Bottom longitudinals are to be continuous through floors or to be attached to the floors so as to have sufficient fixing strength against bending and tension.

10.5.2 Spacing of Bottom Longitudinals

The standard spacing of bottom longitudinals is 500 mm.

10.5.3 Section Modulus of Bottom Longitudinals

The section modulus of bottom longitudinals is not to be less than obtained from the following formula:

$55.6Shl^2$ (cm^3)

Where:

l: Spacing of bottom transverses (m);

S: Spacing of bottom longitudinals (m);

h: Vertical distance from the bottom longitudinals to a point d +0.026L (m) above the base point of D (m). Where, however, the distance is less than 0.5D (m), h is to be taken as 0.5D (m).

10.5.4 Bottom Transverses Supporting Bottom Longitudinals

Where longitudinal framing is adopted in the bottom construction, bottom transverses supporting bottom longitudinals are to be provided at a spacing not exceeding about 2.4 m. The bottom transverses are to be fitted at every web frame, and the scantlings are not to be less than specified in 10.4.1 and 10.4.2.

10.6 Double Bottoms

10.6.1 General

1 Where bottoms are partially or wholly of double bottom construction, the scantlings of structural members are to be in accordance with the requirements in 10.6.2 to 10.6.6.

2 Bottom laminates under the sounding pipes are to be increased in thickness or to be protected against damages due to sounding rods by suitable means.

3 The thickness of watertight girders and floors, and the scantlings of stiffeners attached to them are to be in accordance with the respective requirements for the relevant girders and floors, and in addition, in accordance with the requirements for deep tanks in Chapter 14.

4 Oiltight cofferdams are to be provided in the double bottom between tanks for carrying oils and those for carrying fresh water such as that for living use, boiler feed water, etc. which may cause any trouble when oil mixes therein.

10.6.2 Centre Girders

1 Webs of centre girders are to extend the whole length of the bottom as far as practicable.

2 The thickness of webs of centre girders is to be in accordance with the requirements in 10.2.1.

10.6.3 Side Girders

1 Where the breadth of ship measured at the top of floors exceeds 4 m, side girders are to be arranged at a suitable spacing.

2 The thickness of webs of side girders is to be in accordance with the requirements in 10.3.2.

10.6.4 Floors

1 Floors are to be fitted at every frame.

2 The scantlings of floors are to be in accordance with the requirements in 10.4.1.

3 Where floors are of single skin construction, stiffeners are to be provided on floors at a suitable spacing.

4 Floors forming lower part of bulkheads are to be in accordance with the requirements for watertight bulkheads in Chapter 13, in addition to those in this Chapter.

10.6.5 Inner Bottom Laminates

1 The thickness of inner bottom laminates is not to be less than obtained from the following formula:

$$11.5S\sqrt{d} \qquad \text{(mm)}$$

Where:

S: Spacing of floors (m).

2 Inner bottom laminates are to be rigidly connected with side shell laminates, bulkhead laminates, etc.

10.6.6 Bottom Longitudinals

1 The construction, scantlings and spacing of bottom longitudinals are to be in accordance with the requirements in 10.5.1, 10.5.2, 10.5.3 and 10.8.

2 The construction and scantling of longitudinals provided on the inner bottom laminates are to be in accordance with the discretion of VR.

10.7 Construction of Strengthened Bottom Forward

10.7.1 Part to be Strengthened

Strengthened bottom forward is the part specified in 7.4.2.

10.7.2 Construction and Scantlings

The scantlings of floors, bottom longitudinals, side girders and centre girders in the strengthened bottom forward are to be properly increased.

10.8 Hat-type Construction

10.8.1 Construction and Scantlings

1 The thickness on one side of webs of centre girders, side girders and floors of hat-type construction are not to be less than 0.7 times the value specified in 10.2.1-2, 10.3.2-1 and 10.4.1 respectively.

2 The sectional areas of top plate laminates of centre girders and side girders of hat-type construction are not to be less than the products of the breadth and the thickness of face plate laminates specified in 10.2.1-3 and 10.3.2-2 respectively.

3 The section modulus of floors and bottom longitudinals of hat-type construction are not to be less than the values specified in 10.4.2 and 10.5.3 respectively.

4 The scantlings of structural members of hat-type construction are to be in accordance with the requirements in 1.3.5, in addition to those in the preceding -1 to -3.

CHAPTER 11 BEAMS

11.1 Beams

11.1.1 Arrangement of Transverse Beams

Transverse beams are, as a rule, to be provided at every frame.

11.1.2 Camber of Weather Deck

It is recommended that the camber of weather deck is to be B /50.

11.1.3 Section Modulus of Beams

The section modulus of beams is not to be less than obtained from the following formula:

$CShl^2$ (cm^3)

Where:

l: Horizontal distance from the inner edge of Beam brackets to the nearest line of support of deck or between the adjacent lines of support of deck (m). Where l is less than 0.25B in the upper deck beams except those at the end parts, l is to be taken as 0.25B. Where l is less than 0.2B in the beams at the end parts of upper deck or in the superstructure deck beams, l is to be taken as 0.2B;

S: Spacing of beams (m);

C: Coefficient given below:

Longitudinal beams:

(a) Midship part: 3.4;

(b) Elsewhere: 2.9.

Transverse beams: 2.9.

h: As specified in 8.2.3 (kN/m^2).Where, however, the value is as specified in 8.2.3-3, h is to be as specified in the following:

(a) Afore 0.3L from the fore end: 0.32L + 0.45 (kN/m^2);

(b) Abaft 0.3L from the fore end: 0.16L + 0.45 (kN/m^2).

11.1.4 End Connections

Beams and frames are to be connected each other by means of brackets. The length of arms of the brackets is not to be less than 1/8 of l specified in 9.4.1.

11.1.5 Beams of Decks Forming Tops of Deep Tanks

The scantlings of beams provided on the decks forming the tops of deep tanks are to be in accordance with the requirements for deep tanks as bulkhead stiffeners regarding the decks as deep tank bulkheads, in addition to those in this Chapter.

11.1.6 Beams of Decks Carrying Specially Heavy Loads

Beams of decks which carry heavy loads such as deck machinery and others are to be properly strengthened.

11.1.7 Transverse Strong Beams Supporting Deck Longitudinals

Where longitudinals framing is adopted in the deck construction, transverse strong beams supporting deck longitudinals are to be provided in a spacing of about 2.4 m. In this case the scantlings and construction thereof are to be in accordance with the discretion of VR.

11.1.8 Hat-type Construction

The scantlings of beams of hat-type construction are to be in accordance with the requirements in 1.3.5, in addition to those in this Chapter.

CHAPTER 12 UNDER-DECK GIRDERS AND PILLARS

12.1 Under-deck Girders

12.1.1 Arrangement

1 At places where beams need to be supported, under-deck girders or equivalent structures are to be provided in accordance with the requirements in this Chapter.

2 Under-deck girders, etc. are to be provided, as necessary, under masts, derrick posts, deck machinery and other heavy concentrated loads

12.1.2 Construction of Girders

Under-deck girders are to be uniform in depth throughout the part between bulkheads and to have sufficient bending rigidity.

12.1.3 Section Modulus of Girders

The section modulus of under-deck girders is not to be less than obtained from the following formula:

$Cbhl^2 \quad (cm^3)$

Where:

b: Distance between the mid-points of spaces from the girder to the adjacent girders or the inner edges of brackets (m) (see Fig. 12.1);

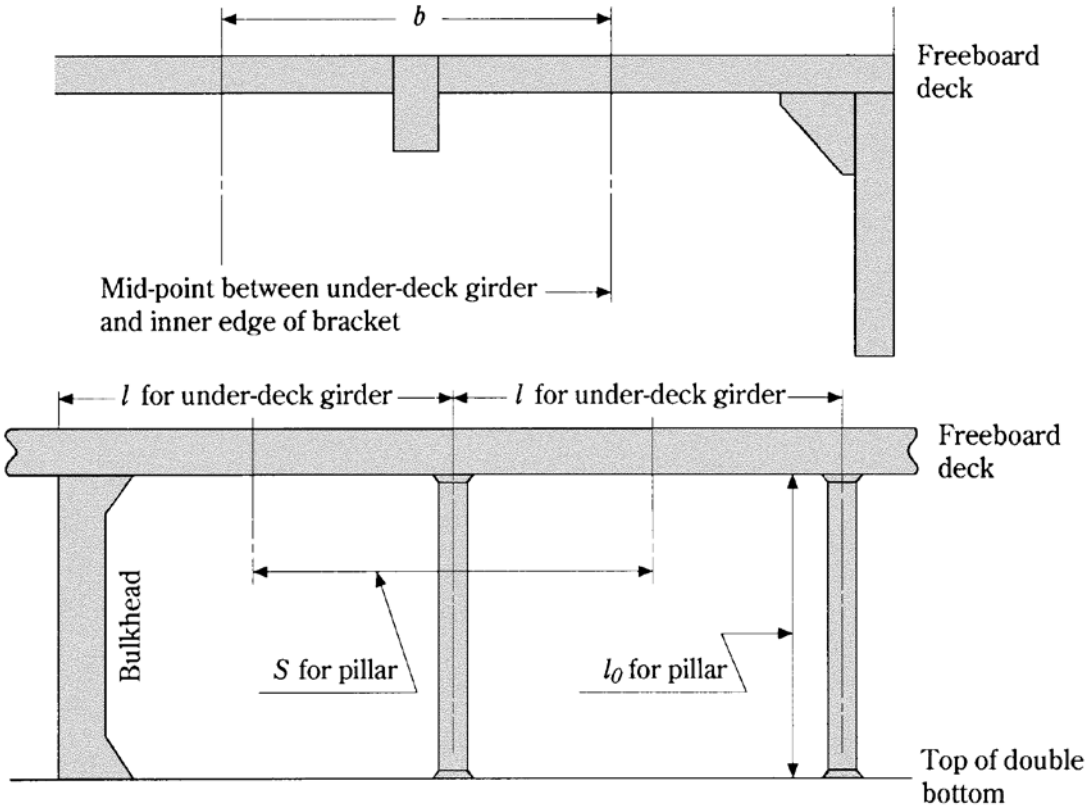


Fig. 12.1 Measurement of b, l, S and l_0

l: Distance between the supporting points of girders (m) (see Fig. 12.1);

h: As specified in 8.2.3 (kN/m^2). Where, however, h is to be in accordance with the requirements in 8.2.3-3, h is to be as specified in the followings:

(a) Afore 0.3L from the fore end: $0.13L + 0.45$ (kN/m^2);

(b) Abaft 0.3L from the fore end: $0.11L + 0.45$ (kN/m^2).

C: Coefficient given below:

(a) Midship part: 4.3;

(b) Elsewhere: 3.4.

12.1.4 Supports and Connections at Ends

1 The ends of under-deck girders are to be supported by bulkhead stiffeners. These stiffeners are to be properly strengthened.

2 Where two adjacent under-deck girders or an under-deck girder and a longitudinal bulkhead are not in line in way of a transverse bulkhead, etc., each of them is to be extended beyond the transverse bulkhead, etc. for at least one frame space.

12.1.5 Hat-type Construction

The scantlings of under-deck girders of hat-type construction are to be in accordance with the requirements in 1.3.5, in addition to those in this Chapter.

12.2 Pillars

12.2.1 Application

Pillars supporting beams are to be in accordance with the requirements in this Chapter.

12.2.2 Pillars under Concentrated Loads, etc.

Special supports, by providing pillars or by other suitable means, are to be arranged at the ends and corners of deckhouses, in machinery spaces, at the ends of partial superstructures and under heavy concentrated loads.

12.2.3 Sectional Area of Pillars

1 The sectional area of pillars which are made of steel, is not to be less than obtained from the following formula:

$$\frac{0.223Sbh}{2.72 - \frac{l_0}{k_0}} \qquad (cm^2)$$

Where:

S: Distance between the mid-points of the spaces from the pillar to the adjacent pillars or to the bulkhead (m) (see Fig. 12.1);

b: Distance between the mid-points of the spaces from the pillar to the adjacent pillars or to the inner edges of brackets (m) (see Fig. 12.1);

h: As specified in 12.1.3;

l_0 : Distance from the lower end of pillar to the lower surface of girder or beam supported by the pillar (m) (see Fig. 12.1);

k_0 : Value obtained from the following formula:

$$\sqrt{\frac{I}{A}}$$

I: Minimum moment of inertia of pillar (cm^4);

A: Sectional area of pillars (cm^2).

2 The sectional area of pillars which are made of wood is not to be less than obtained from the following formula:

$$\frac{1.32Sbh}{1.51-\frac{l_0}{k_o}} \qquad (cm^2)$$

Where:

S, b, h, l_0, k_0 : As specified in the preceding -1.

CHAPTER 13 WATERTIGHT BULKHEADS

13.1 Arrangement of Watertight Bulkheads

13.1.1 Collision Bulkheads

FRP ships are to be provided with a collision bulkhead at a position between 0.05L (m) and 0.13L (m) from the fore side of the stem on the load line.

13.1.2 Aft Peak Bulkheads

1 All FRP ships are to be provided with aft peak bulkheads at a suitable position.

2 Stern tubes are to be provided in a watertight compartment by means of an aft peak bulkhead or any other suitable arrangements.

13.1.3 Bulkheads of Machinery Space

Watertight bulkhead is to be provided at each end of the machinery space.

13.1.4 Height of Watertight Bulkheads

1 The watertight bulkheads required in 13.1.1 to 13.1.3 are to extend at least to the upper deck except for those specified in the following (1) to (3):

(1) The watertight bulkheads in way of the sunken poop or the sunken forecastle is to extend to the sunken poop deck or the sunken forecastle deck;

(2) Where a forecastle having opening without closing appliances led to a space below the freeboard deck is provided or where a long forecastle not less than 0.25L in length is provided, the collision bulkhead is to extend up to the superstructure deck. In this case, the extend part may have steps within the limit of distance specified in 13.1.1 and may be made weathertight;

(3) Where a deck below the upper deck but above the load line is extended to the stern from the aft peak bulkheads and made watertight, the aft peak bulkhead may terminate at the afore-mentioned deck. In this case, however, the transverse strength and transverse stiffness of the hull are to be maintained by providing web frames of partial bulkheads extending up to the upper deck, directly above or in the vicinity of the aft peak bulkhead.

13.1.5 Chain Lockers

1 Where chain lockers are provided abaft the collision bulkhead or in the fore peak tank, they are to be made watertight and provided with means of drainage by pump.

2 Chain lockers are to be provided with screen walls at centre line.

13.2 Construction of Watertight Bulkheads

13.2.1 Thickness of Bulkhead Laminates of Single Skin Construction

The thickness of bulkhead laminates of single skin construction is not to be less than obtained from the following formula:

$12S\sqrt{h}$ (mm)

Where:

S: Space of stiffeners (m);

h: Vertical distance from the lower edge of bulkhead laminate to the top of upper deck laminate at the centre line of the ship (m). However, for the collision bulkhead, the value specified above is to be multiplied by 1.25.

13.2.2 Thickness of Bulkhead Laminates of Sandwich Construction

1 The aggregated thickness of the inner layers, outer layers and cores of bulkhead laminates of sandwich construction is not to be less than obtained from the following formulae, whichever is greater:

C_1Sh (mm);

C_2t_f (mm)

Where:

t_f : Thickness in case of single skin construction specified in 13.2.1 (mm);

h: As specified in 13.2.1 (m);

S: Spacing of stiffeners (mm);

C_1 and C_2 : As specified in 7.3.3-1.

2 The respective thicknesses of the inner layers and outer layers of bulkhead laminates of sandwich construction are not, notwithstanding the requirements in the preceding -1, to be less than obtained from the following formula. In no case, however, is it less than 2.4 mm.

$3.6\sqrt[3]{C_4(Sh)^4}$ (mm)

Where:

S: Spacing of stiffeners (m);

h: As specified in 13.2.1 (mm);

C_4 : As specified in 7.3.3-2.

13.2.3 Bulkhead Laminates of Structural Plywood

Where structural plywoods are used for bulkhead plates, the thickness of plywoods is not to be less than specified by the requirements in 13.2.1 multiplied by the coefficient given in 1.3.4-2(1). However, σ_B is to be taken as bending strength (N/mm^2) of plywoods.

13.2.4 Bulkheads Stiffeners

The section modulus of bulkhead stiffeners is not to be less than obtained from the following formula:

$CShl^2$ (cm^3)

Where:

l: Total length between adjacent supports of stiffener (m) including the length of connection at the end. Where, however, girders are provided, l is the distance from the heel of end connection to the nearest girder or the distance between girders;

h: 0.8 times the vertical distance from the mid-point of l to the top of upper deck laminate at the centre line of ship plus 1.2 (m). However, for the collision bulkhead, the above-mentioned value is to be multiplied by 1.25;

S: Spacing of stiffeners (m);

C: Coefficient given below:

(a) Where the both ends of stiffeners are attached by brackets: 20;

(b) Where the ends of stiffeners are snipped: 30.

13.2.5 Girders Supporting Bulkhead Stiffeners

Webs of girders supporting bulkhead stiffeners are to be connected to the bulkhead laminates and the section modulus of girders is not to be less than obtained from the following formula:

$34Shl^2 \quad (cm^3)$

Where:

l: Total length of girders including the length of end connection (m);

S: Breadth of the area supported by the girders (m);

h: 0.8 times the vertical distance from the mid-point of S to the top of upper deck laminate at the centre line of ship plus 1.2 (m). However, for the collision bulkhead, the above-mentioned value is to be multiplied by 1.25.

13.2.6 Hat-type Construction

The scantlings of bulkhead stiffeners and girders of hat-type construction are to be in accordance with the requirements in 1.3.5, in addition to those in this Chapter.

CHAPTER 14 DEEP TANKS

14.1 General

14.1.1 Definition

The deep tank is a tank used for carriage of water, fuel oil and other liquids, forming a part of the hull in holds or tween decks. The deep tanks used for carriage of oils are designed as deep oil tanks, if necessary.

14.1.2 Earthing

Metallic parts, pipes, etc. in tanks are to be properly earthed.

14.1.3 Application

1 The construction of all watertight division walls, aft peak tanks and all deep tanks in holds and between decks excluding deep oil tanks for carriage of oils having a flashpoint below 60 °C is to be in accordance with the requirements in this Chapter. The part concurrently serving as a watertight bulkhead is to be in accordance with the requirements for watertight bulkheads.

2 The construction of deep oil tanks for carriage of oils having a flashpoint below 60 °C is to be in accordance with the discretion of VR.

14.1.4 Division Walls in Tanks

1 Deep tanks are to be of proper size and to be provided with longitudinal division walls to meet the necessity for stability under service conditions as well as during filling or discharging.

2 Fresh water tanks, fuel oil tanks and other deep which are not intended to be kept entirely filled in service conditions are to be provided with additional division walls or deep wash plates as necessary as to minimize the dynamical forces acting on the structural members.

3 Where it is impracticable to be in accordance with the requirements in the proceding -2, the scantlings of structural members specified in this Chapter are to be properly increased.

14.1.5 Consideration for Watertightness of Tanks

Frames and beams are not to pass through the top laminates and bulkheads laminates of deep tanks.

14.2 Bulkhead Laminates of Deep Tanks

14.2.1 Thickness of Bulkhead Laminates of Single Skin Construction

The thickness of bulkhead laminates of single skin construction is not to be less than obtained from the following formula:

$13S\sqrt{h}$ (mm)

Where:

S: Spacing of stiffeners (m);

h: Vertical distance measured from the lower edge of bulkhead laminate to the mid-point of the height between the top of overflow pipe and the top of tank (m).

14.2.2 Thickness of Bulkhead Laminates of Sandwich Construction

1 The aggregated thickness of the inner layer, outer layer and core of the bulkhead laminates of sandwich construction is not to be less than obtained from the following formulae, whichever is greater:

C_1Sh (mm);

C_2t_f (mm).

Where:

t_f : Thickness in case of single skin construction specified in 14.2.1 (mm);

h: As specified in 14.2.1 (m);

S: Spacing of stiffeners (mm);

C_1 and C_2: As specified in 7.3.3-1.

2 The respective thicknesses of the inner layer and outer layer of bulkhead laminates of sandwich construction are not, notwithstanding the requirements in the preceding -1, to be less than obtained from the following formula. In no case, however, is it to be less than 2.4 mm.

$3.6\sqrt[3]{C_4(Sh)^4}$ (mm)

Where:

S: Spacing of stiffeners (m);

h: As specified in 14.2.1 (mm);

C_4: As specified in 7.3.3-2.

14.2.3 Bulkhead Laminates of Structural Plywood

Where structural plywood are used for bulkhead plates, the thickness of plywoods is not to be less than specified by the requirements in 14.2.1multiplied by the coefficient given in 1.3.4-2(1). However, σ_B is to be taken as bending strength (N/mm^2) of plywoods.

14.2.4 Bulkhead Stiffeners

The section modulus of bulkhead stiffeners is not to be less than obtained from the following formula:

$CShl^2$ (cm^3)

Where:

S and l: As specified in 13.2.4;

h: Vertical distance measured from the mid-point of l to the mid-point of the height between the top of overflow pipe and the top of tank (m);

C: Coefficient given below:

(a) Where the both ends of stiffeners are attached by brackets: 28;

(b) Where the ends of stiffeners are snipped: 42.

14.2.5 Girders Supporting Bulkhead Stiffeners

The section modulus of girders supporting frames and bulkhead stiffeners is not to be less than obtained from the following formula:

$42Shl^2$ (cm^3)

Where:

l: Total length of girders including the length of end connection (m);

S: Breadth of the area supported by the girders (m);

h: Vertical distance measured from the mid-point of S to the mid-point of the height between the top of overflow pipe and the top of tank (m).

14.2.6 Hat-type Construction

The scantlings of bulkhead stiffeners and girders of hat-type construction are to be in accordance with the requirements in 1.3.5, in addition to those in this Chapter.

14.2.7 Structural Members Forming Top and Bottom of Deep Tanks

The scantling of the structural members forming the top and the bottom of deep tanks are to be in accordance with the requirements in this Chapter regarding the members as the bulkheads of deep tanks at the location. In no case, however, are they to be less than required for the deck laminates, etc. at the location.

14.3 Provisions for Deep Tanks

14.3.1 Limber and Air Holes

In deep tanks, suitable limber and air holes are to be cut in the members to ensure that water or air does not remain stagnated in any part of the tanks.

14.3.2 Cofferdams, etc.

1 Oiltight cofferdams are to be provided between tanks for carrying oils and those for carrying fresh water such as that for living use, boiler feed water, etc., which may cause any trouble when oil mixes therein.

2 Crew spaces and passenger spaces are not to be directly adjacent to the tanks for carriage of fuel oil. Such compartments are to be separated from fuel oil tanks by cofferdams which are well ventilated and accessible. Where the top of fuel oil tanks has no opening and is coated by incombustible coverings of 38 mm and over in thickness, the cofferdam between such compartments and the top of fuel oil tanks may be omitted.

3 Sparring or lining is to be provided in the hold side of bulkhead dividing deep oil tanks from cargo holds, leaving suitable clearance between the bulkhead and the sparring or lining. Gutterways are to be provided along the bulkhead.

4 Where the oiltank boundaries are bonded by matting-in connections in way of the parts required oiltight, the sparring or lining specified in -3 may be omitted, except where specially required.

CHAPTER 15 MACHINERY SPACES

15.1 General

15.1.1 Application

The construction of machinery spaces is to be in accordance with the requirements in the relevant chapter, in addition to those in this Chapter.

15.1.2 Strengthening

Machinery spaces are to be provided with web frames, strong beams, widely spaced pillars, etc. or to be strengthened by any other suitable means.

15.1.3 Supporting Structures for Machinery, Shaftings, etc.

Machinery, shaftings, etc. are to be effectively supported and the adjacent structures are to be sufficiently strengthened.

15.1.4 Means of Escape

In main engine room, at least one set of means of escape which is formed of a door fitted up to the machinery casing and steel ladders leading to the door is to be provided.

15.2 Construction under Main Engines

15.2.1 Construction under Main Engines

1 Girders upon which main engines are installed are to be of sufficient length as to the engine foundations, and the form is not to have any abrupt changes or discontinuities.

2 Girders are to be effectively supported by frames and brackets in order to maintain sufficient lateral strength and rigidity..

3 Where engines which have large unbalanced inertia force or large unbalanced moment of inertia are installed, the strength and rigidity of the girders supporting those engines are to be made especially sufficient.

4 Fixing bolts for main engines are to have adequate shank length in order to lower their rigidity and effective means to avoid loosening.

5 Where engines which are subjected to large exciting force due to piston side thrust are installed, the connections of girders with frames and brackets are to be made rigid, and resonance is to be avoided against the vibration in the horizontal direction.

6 Webs of girders may be constructed with timbers interposed between FRP in order to increase the rigidity against compression or bending. In this case, the connections of FRP with timbers and of timbers with bottom shell laminates are to be effectively bonded.

7 The bonded connections of girders with bottom shell laminates, frames and brackets, as well as their mutual connections are to be T-type joints using ample roving cloths and the width of joints is to be sufficient. In this case, the direction of roving cloth fibres is not, as a rule, to be oblique to the connecting line.

CHAPTER 16 SUPERSTRUCTURES AND DECKHOUSES

16.1 General

16.1.1 Application

1 The construction and scantlings of superstructures and deckhouses are to be in accordance with the requirements in the relevant chapters, in addition to those in this Chapter.

2 For FRP ships with specially large freeboard, the requirements in this Chapter may be properly modified, subject to the approval by VR.

16.2 Construction, etc.

16.2.1 Scantlings of End Bulkheads and Boundary Walls

The thickness of plates and the scantlings of stiffeners of superstructure end bulkheads and deckhouse boundary walls are not to be less than given in Table 16.1. Where the spacing of stiffeners S is different from 500 mm, the thickness of plates and the section modulus of stiffeners are not to be less than obtained from the Table 16.1 below, multiplied by S/500.

Table 16.1 Thickness of Plates and Scantlings of Stiffeners of Superstructure End Bulkheads and Deckhouse Boundary Walls

L (m)		Front wall		Side and aft wall	
Over	Not more than	Thickness of boundary wall (mm)	Section modulus of stiffener (cm^3)	Thickness of boundary wall (mm)	Section modulus of stiffener (cm^3)
	15	5.0	35	4.0	20
15	20	5.5	40	4.0	20
20	24	5.5	47	4.0	24
24	27	6.5	56	5.0	28
27	30	6.5	67	5.0	33
30	33	6.5	82	5.0	37
33	35	7.0	97	5.5	42

16.2.2 Closing Means for Access Openings and Height of Sills

1 The doors to be provided on the access openings in the end bulkheads of enclosed superstructures and those in the deckhouses protecting companionways giving access to the spaces under the freeboard deck or the spaces in the enclosed superstructures are to be in accordance with the requirements in the following (1) to (5):

(1) The doors are to be permanently and rigidly fitted up to the walls;

(2) The doors are to be rigidly constructed, to be of equivalent strength to that of intact wall and to be weathertight when closed;

(3) The means for securing weathertightness are to consist of gaskets and clamping devices or other equivalent devices and to be permanently fitted up to the wall or the door itself;

(4) The doors are to be operated from the both sides of the wall;

(5) Hinged doors are, as a rule, to open outward.

2 The height of sills of access openings specified in the preceding -1is to be at least 380 mm above the upper surface of the deck.

CHAPTER 17 HATCHWAY OPENINGS, MACHINERY OPENINGS AND OTHER DECK OPENINGS

17.1 General

17.1.1 Application

1 The requirements in this Chapter apply to FRP ships other than those engaged in international voyages.

2 FRP ships which are engaged in international voyages are to comply with the requirements in Part 11 Section II QCVN 21: 2010/BGTVT.

17.2 Hatchway Openings

17.2.1 Height of Hatch Coamings

1 The height of hatch coamings above the upper surface of deck laminates is not to be less than given in Table 17.1.

Table 17.1 Height of Hatch Coamings

Position of hatchway openings		$L \leq 20$ m	$20 \text{ m} < L \leq 30$ m	$30 \text{ m} < L \leq 35$ m
Exposed hatchway openings	On the upper deck	380 mm	450 mm	600 mm
	On the superstructure decks for 0.25L from the fore end	380 mm	450 mm	600 mm
	On the superstructure decks other than the above	300 mm	300 mm	450 mm
Un-exposed hatchway openings	On the decks in the unenclosed superstructures except for specified below	380 mm	380 mm	450 mm
	On the decks in superstructures without front bulkheads	380 mm	450 mm	600 mm

2 With respect to hatchway opening which are maintained weathertight by means of gaskets and clamping devices and closed with substantial weathertight covers, the height of hatch coamings may be reduced from required in the proceeding -1, subject to the approval by VR.

17.2.2 Wooden Covers

1 Wooden covers are to be in accordance with the requirements in the following (1) to (3):

(1) The finished thickness of wooden covers is not to be less than obtained from the following formula. Wooden covers intended to carry cargoes thereon are to be increased in thickness in direct proportion either where the tween deck height exceeds 2.6 m or where the weight per unit area of cargoes to be carried on the hatchway exceeds 18 kN/m^2. In no case, however, is the finished thickness to be less than 48 mm.

30S (mm)

Where:

S: Spacing of hatch beams (m).

(2) Materials for wooden covers are to be of good quality, straight grained and reasonably free from knots, sapwood and shakes.

(3) The ends of wooden covers are to be protected by circling steel bands.

17.3 Machinery Openings

17.3.1 Protection of Machinery Openings

Machinery openings are to be as small as possible, and to be enclosed by casings.

17.3.2 Casings of Machinery Openings in Exposed Parts

1 Exposed machinery openings on the upper decks and superstructure decks are to be in accordance with the requirements in the following (1) to (2):

(1) The thickness of casings and the section modulus of stiffeners thereupon, are to be equivalent to those of boundary walls of deckhouses specified in 16.2.1;

(2) The thickness of top laminates of casings and the section modulus of stiffeners thereupon, are not to be less than 4.0 mm and 24 cm^3 respectively.

2 The height of casings is not, except special cases, to be less than that of bulwarks.

3 Where access openings are provided on the exposed machinery casings, these openings are to be located in protected spaces as far as practicable, the doors thereof are to be in accordance with the requirements in 16.2.2-1 and the height of sills above the upper surface of deck laminates is to be at least 380 mm.

17.3.3 Machinery Casings Provided in Enclosed Parts

Where access openings are provided of the machinery casings, the doors thereof are to be substantial.

17.3.4 Position of Fittings

Skylights provided on the top laminates of machinery casings are to be of substantial construction and coamings of funnels and ventilators are to be provided as high as possible above the weather deck laminates.

17.4 Companionway Openings and Other Deck Openings

17.4.1 Manholes and Flush Deck Openings

Manholes and flush deck openings which are provided in exposed parts of freeboard deck and superstructure decks or in the superstructures other than those enclosed, are to be closed with substantial covers capable of keeping watertightness.

17.4.2 Companionways

1 Companionways on the freeboard deck are to be protected by enclosed superstructures or by deckhouses or companions which have strength and weathertightness equivalent to those of enclosed superstructures.

2 Companionways on exposed superstructure decks and those on the top of deckhouses on the freeboard deck which give access to spaces below the freeboard deck or space within enclosed superstructures, are to be protected by effective deckhouses or companions.

3 Access openings in the deckhouses or companions specified in the preceding -1 and -2 are to be provided with doors in accordance with the requirements in 16.2.2-1. And the

height of sills of the access openings above the surface of deck laminates is to be at least 380 mm.

17.4.3 Openings to Cargo Space

All of access and other openings to cargo spaces are to be provided with closing means capable of being operated from outside the spaces in case of fire.

CHAPTER 18 BULWARKS, GUARDRAILS, FREEING ARRANGEMENT, SIDE OPENINGS, SCUTTLES, VENTILATORS AND GANGWAYS

18.1 General

18.1.1 General

1 FRP ships defined in 20.1.1-1 are to comply with the requirements in Chapter 21 Part 2A, Section II of QCVN 21: 2010/BGTVT.

2 In FRP ships other than specified in the preceding -1, the arrangement and construction of those are to be in accordance with the discretion of VR.

CHAPTER 19 MACHINERY

19.1 General

19.1.1 Application

Prime movers, power transmission system, shaftings, pressure vessels, auxiliaries, piping systems and electrical installations are, as a rule, to be in accordance with the requirements in the relevant chapters, except those specified in this Chapter.

19.2 Installation of Propulsion Machinery, Fuel Oil Tanks and Earthing

19.2.1 Installation of Propulsion Machinery

1 Propulsion machinery, except for those of small output, are to be installed on the bottom girders through the steel engine seatings of sufficient strength and rigidity..

2 Where machinery having large unbalanced inertia force or large unbalanced moment of inertia or subjected to large exciting force due to piston side thrust are installed, it is recommended that the steel engine seatings are of sufficient length for the engines and the engine seatings on both sides are connected each other or the engine seatings are of solid construction.

3 Where the temperature of the bedplates for propulsion machinery or engine seatings in contact with the FRP girders may become the value to give bad influence on the creeping property of FRP in a normal operating condition, an effective insulation is to be provided between the bedplates or seatings and FRP girders.

4 Considerations are to be given to installation of propulsion machinery or propulsion machinery seatings onto the FRP girders so that an excessive creep deformation does not occur due to the weights and clamping forces of bolts.

19.2.2 Fuel Oil Tanks

The surfaces of fuel oil tanks made of FRP facing the spaces such as main engine rooms, etc. where there may be usually heat of fire and to be provided with proper measures for flame retardation and flame-resistance. In case of engines using petrols, the fuel oil tanks are to be metallic.

19.2.3 Earthing

1 Coverings of metallic structures, machinery and equipment in danger of electrification due to static electricity or electromagnetic induction, are to be effectively earthed, except where is no risk of persons to touch them directly.

2 Metallic fuel oil tanks and pipes are to be effectively earthed. Where FRP fuel oil tanks are used, the metallic parts of valves, manhole covers, etc. fitted up in the tanks and the fuel oil pipes are to be electrically connected effectively, and they are to be earthed.

III REGULATIONS ON MANAGEMENT

1.1 General

Where compliance with this Regulation is made, FRP ship is to have a notation "FRP" affixed to the characters of classification defined in Chapter 2 Part 1A Section II QCVN 21: 2010/BGTVT.

1.2 Regulations on technical supervisions

FRP ship is to be subject to surveys specified in Chapter 2 Section II of this Regulation.

1.3 Certification

1.3.1 Certificate

If a ship complies with this Regulation, the ship is to be issued a certificate of design approval or a classification certificate depending on each particular demand.

1.3.2 Procedure for certification

Procedure for certification of FRP ships is to be in accordance with Circular No. 32/2011/TT-BGTVT, similar to sea-going ships.

IV RESPONSIBILITIES OF ORGANIZATIONS, INDIVIDUALS

1.1 Responsibilities of ship owners and operators, design company, manufacturing, converting, renovating and repairing the ships

1.1.1 Ship owners and Operators

1 To implement all relevant requirements in this Regulation in manufacturing, converting, renovating, operating the FRP ships in order to ascertain and maintain good technical condition of the ships.

1.1.2 Design companies

1 To design FRP ships in compliance with requirements of the Regulation.

2 To submit all required design documentation in accordance with requirements in the Regulation.

1.1.3 Yards of manufacturing, converting, renovating and repairing FRP ships

1 To be capable in terms of warehouse, manufacturing shop, building facilities etc. and competent manpower to meet requirement for new manufacture, conversions, renovations and repairs of the ships.

2 To comply with standards of quality, safety while manufacturing, converting, renovating and repairing the ships and to comply with approved design.

3 To be subjected to VR's supervision on the technical quality and safety of the systems.

1.2 Responsibilities of Vietnam Register

1.2.1 Design approval, technical supervision

To assign surveyors having competence and of sufficient standard to carry out the technical supervision during manufacture, conversions, renovations, repairs and operation of the ships in accordance with technical requirements specified in this Regulation.

1.2.2 To give instructions for implementation/application

To give instructions for the application of requirements of this Regulation to ship owners and operators, yards of manufacture, conversions, renovations and repair of the ships, inspection offices of Vietnam Register throughout the country.

1.2.3 To amend and supplement the Regulation

Based on the fact, Vietnam Register is to have responsibility to petition the Ministry of Transport for amendment, supplementation of the Regulation where necessary or on schedule specified in the Law of Standards and Technical Regulations.

1.3 Responsibilities of the Ministry of Transport

The Ministry of Transport (Science and Technology department) is responsible for verifying on the regular or random basis the implementation of this Regulation by relating organizations.

V IMPLEMENTATION

1.1 It is the responsibility of Vietnam Register to manage the survey system, technical supervision, classification and technical registration of FRP ships. It is also to include organizing the printing, dissemination and instructions for the application of this Regulation for organizations and individuals falling within the scope of this Regulation.

1.2 In case of inconsistency between the requirements in this Regulation and those in other rules, standards or technical regulations relating to FRP ships, the requirements of this Regulation are to prevail over those of others.

1.3 In case the documents referred to in this Regulation are amended, supplemented or replaced, the latter is to prevail over the former.

1.4 In case of inconsistency between the requirements of this Regulation and those of international Conventions to which Vietnam is a member, the requirements of those international Conventions are to prevail over the requirements of this Regulation for ships engaged in international voyages.

1.5 This Regulation and its amendment applies to ships of which early stages of the new building or date of major conversions are on or after effective date of this Regulation.