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An American National Standard

Standard Guide for Doubler Plate Repairs for Non-Classed Ship Structures[1]

This standard is issued under the fixed designation F2991; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers information for designing permanent steel doublers for surface ships that are not classed with any classification society, and not load line certified. It is not intended to supersede any classification or statutory requirements.

1.2 This guide provides owners, operators, shipyards, and designers with information for designing and using doubler plates so that the damaged structure regains its original local strength.

1.3 When the steel is to be welded a welding procedure suitable for the grade of steel and intended use or service is to be utilized. See Appendix X3 of Specification A6/A6M for information on weldability.

1.4 The values stated in metric units (SI) are to be regarded as the standard. The values given in parentheses (inch/pound) are provided for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A36/A36M Specification for Carbon Structural Steel

A131/A131M Specification for Structural Steel for Ships

2.2 *Other Documents:*

AWS D 1.1 Structural Welding Code[3]

NVIC 7-68 Navigation and Vessel Inspection Circulars[4]

SSC-443 Design Guidelines for Doubler Plate Repairs of Ship Structures[5]

3. Terminology

3.1 *Definitions:*Definitions of Symbols Specific to This Standard:

3.1.1 *combustible liquid*—liquid having flashpoint above 80°F (Grade D and E liquid).

3.1.2 *corrosion*—a state of deterioration in metals caused by oxidation or chemical reaction.

3.1.3 *doubler plate*—a plate lap welded to damaged part of a structure to regain its original local strength.

3.1.4 *flammable liquid*—liquid having flashpoint at or below 80°F (Grade A, B and C liquid)

3.1.5 *fracture*—fracture occurs when metal experiences stresses that exceed ultimate strength.

3.1.6 *tank vessels*—all vessels (tank barges and tankships) carrying combustible or flammable liquid cargo in bulk.

4. Introduction

4.1 The intent of this guide is to design and weld a doubler plate to the damaged portion of the structure so that the damaged structure regains its original local strength. This guide should be used to design a specific doubler plate for a specific damage.

4.2 These guidelines are based on the study performed on behalf of Ship Structure Committee (SSC) and are published in the report SSC-443.

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[1] This test method is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.01 on Structures.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

[4] Available from the United States Coast Guard (USCG) website: http://www.uscg.mil/hq/cg5/nvic/

[5] Available from the Ship Structure Committee website: http://www.shipstructure.org/

4.3 This guide can be used to repair damages caused by corrosion and pitting and is applicable to all surface type steel vessels. This guide does not apply to submarines and pressure vessels.

4.4 This guide does not cover straps welded to deck and side shell to increase the section modulus of the vessel.

4.5 The size of doubler plate depends on the size, thickness and location of the damaged structure. The design of the doubler plate shall be in accordance with Fig. 1(a and b) and Table 1, and include:

4.5.1 Thickness
4.5.2 Dimension
4.5.3 Corner radius
4.5.4 Overlap
4.5.5 Welding type (slot vs. fillet weld)

5. Applicability of Doubler Plates

5.1 Doublers can be used if:

5.1.1 Reduction in plate thickness is less than 25 % of the original thickness.

5.1.2 Reduction in web thickness of girders/frame/stiffeners is less than 20 % of the original thickness.

5.1.3 Reduction in flange thickness of girders/frame/stiffeners is less than 20 % of the original thickness.

5.1.4 Indentation is less than twice the plate thickness

5.2 Doubler plates cannot be used in the following locations:

5.2.1 Tanks carrying combustible and flammable liquids.

5.2.2 There are many scattered patches clustered together, or a large area, unless the sum of the area(s) is less than 15 % of the total deck or bottom area and not situated within 0.4L admidship.

5.3 *Hull Girder Strength:*

5.3.1 If many patches cluster together or a large area of deck or bottom admidship is involved, the hull girder longitudinal stress shall not increase by 15 % or more.

6. Materials and Manufacture

6.1 Doubler plate shall be of material with physical properties equal to or better than that of the parent plate.

6.2 Steel shall conform to the requirements of Specification A36/A36M, A131/A131M, or equivalent.

6.3 Welding shall conform to AWS D 1.1 or equivalent.

6.4 Proper design and controlled welding procedures shall be followed.

6.5 Welders are to be qualified in accordance with the recognized standards of an IACS Classification Society or to a recognized national or international standard.

7. Dimensions

7.1 The dimensions shall be in accordance with Table 1.

7.2 Dimensions are given in millimetres (mm).

8. Workmanship, Finish, and Appearance

8.1 Doubler plate shall be free sharp edges, burrs, carburized flame cut material, and weld spatters.

8.2 *Finish*—Doubler plate shall be sand or shot blasted to remove rust and scale and given a complete coat of primer/topcoat based on the environment and compatibility with coatings on the existing structure.

8.3 Welds are to be inspected by a certified NDT Level II inspector.

9. Inspection

9.1 All doubler plates shall be visually inspected for workmanship, finish, and appearance as defined in Section 8.

10. Keywords

10.1 crack; damage; doubler; failure; fracture; structures; welds

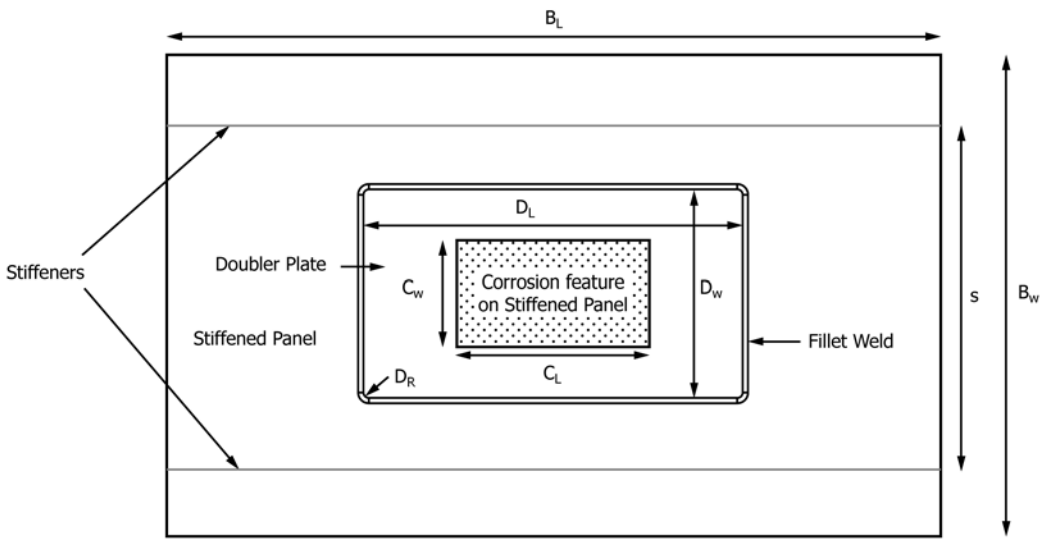

FIG. 1 a Doubler Plate Geometry

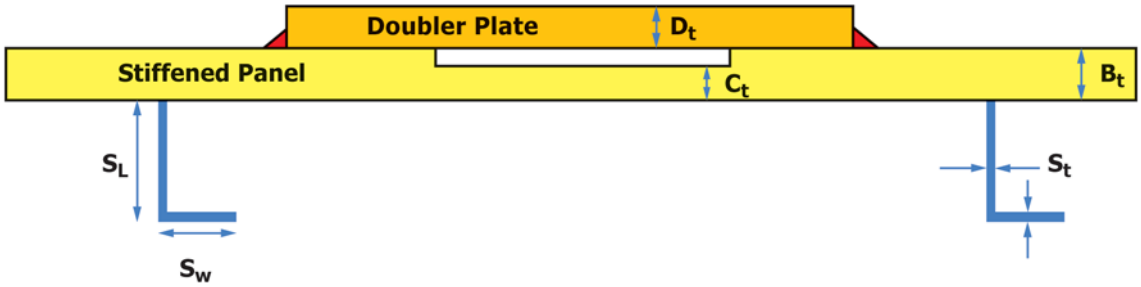

FIG. 1 b Doubler Plate Geometry *(continued)*

TABLE 1 Recommended Guidelines for Doubler Plate Repairs

Item	Guidelines
Minimum Damage Thickness (C_t)	$C_t \geq 0.75 * B_t$
Doubler Thickness (D_t)	$\geq 0.65 * Bt$
Overlap (S_o)	$50 \leq S \leq 100$ mm
Doubler Corner Radius (D_R)	$D_R = 85 * (D_t/B_t)$ (D_R minimum = 50 mm)
Circular Doubler	Minimum 200 mm in diameter
Material Grade	Same as parent plate or compatible
Welding	As for new construction
Weld Size (throat thickness)	$0.6 * D_t$

11. Nomenclature

B_L = length of stiffened panel
B_W = width of stiffened panel
B_t = thickness of stiffened panel
C_L = length of damaged/corroded portion
C_W = width of damaged/corroded portion
C_t = remaining thickness of stiffened plate after damage/corrosion
D_L = length of doubler plate
D_W = width of doubler plate
D_t = thickness of doubler plate
D_R = fillet radius of doubler plate
s = stiffener spacing of stiffened plate
S_L = height of stiffener web
S_W = width of stiffener flange
S_t = thickness of stiffener web and flange
S_o = size of overlap [$0.5*(D_L - C_L)$ or $0.5*(D_W - C_W)$]
t_w = weld leg length