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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Health, Labour and Welfare, and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by the High Pressure Gas Safety Institute of Japan (KHK) / Japanese Standards Association (JSA), with the draft being attached, based on the provision of Article 12 clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently JIS B 8284:1993 is replaced with this Standard.

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Quick closure for pressure vessels

1 Scope This Japanese Industrial Standard applies the calculation of the pressure parts (including load transmission parts) of quick closure for pressure vessels of design pressure less than 100 MPa and design temperature 250 °C or lower. However, the following quick closures are not included. The application of them shall be in accordance with relevant regulations or standards for pressure vessels.

- a) Those which are exposed to flame directly.
- b) Those which are under particular conditions of significant thermal stress and thermal impact.

Remarks : The strength calculation of the self fastening system clamp type pipe fittings used for piping and the like may be in accordance with this Standard.

2 Normative references The following standards contain provision which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) shall be applied.

JIS B 0190 *Glossary of terms used in construction of pressure vessels*

JIS B 8265 *Construction of pressure vessel — General principles*

JIS B 8266 *Alternative standard for construction of pressure vessels*

3 Definitions For the purposes of this Standard, the definitions given in JIS B 0190 and the following definitions apply.

- a) **pressure** Unless particularly defined clearly, the gauge pressure.
- b) **design pressure** The pressure used for the design load condition.
- c) **design temperature** The temperature used for the design load condition.
- d) **clamps** The members for connecting the shell side flanges and cover plate, and of which structure is as shown in figure 1 and figure 2.
- e) **solid clamp type** The structure with which the lugs of shell side flange and lugs of cover plate are to be connected each other, and clamp is of the solid type.
- f) **split clamp type** The structure in which the shell side flange and cover plate are connected, and the clamps are split. Usually that splits into two parts is used.
- g) **integral type with lugs** This is a type that shell and clamp are integrated, having a structure of which lugs connect with the lugs of cover plate.
- h) **sectional ring type** This is a type that shell and clamp are integrated, having a structure in which the cover plate is retained by the sectional ring.

- i) **yoke frame type** This is a type which is so constructed that the cover plate attached to the both ends of pressure vessel shell are retained by rectangular or obround type yoke frame.
- j) **clamp connection metal fittings** The metal fittings for connecting the split clamps, such as the bolts and lock pins.

- Remarks 1 The design temperature shall be the mean temperature or above (or below, when the design temperature is 0 °C or below) in thickness direction of materials. However, in any case, the surface temperature of material shall not exceed the working limit temperature or the range specified in the table of permissible tensile stress for that material.
- 2 When different temperatures have been set for the individual parts of a pressure vessel, the design temperatures may be specified on respective parts.
- 3 The temperature of material shall either be obtained from the heat transfer calculation formula or be obtained by measuring the temperature of the material and temperature of contained substance, attaching the thermometers (thermocouple, thermistor and the like) to the similar pressure vessel which has already installed under the identical working conditions, as required.

4 Range defined as quick closure and types and part names

4.1 Range defined as quick closure The range defined as the quick closure in this Standard shall be the shell side flange of pressure vessel and lugs, clamp connections, cover plate and its lugs, sectional ring and yoke frame.

4.2 Types of quick closure and part names The quick closure shall be classified as given in the following according to its types.

part names shall be as given in figures 1 to 6.

- a) **Clamp connection type** The clamp connection type shall be the solid clamp type given in figure 1 and the split clamp type given in figure 2

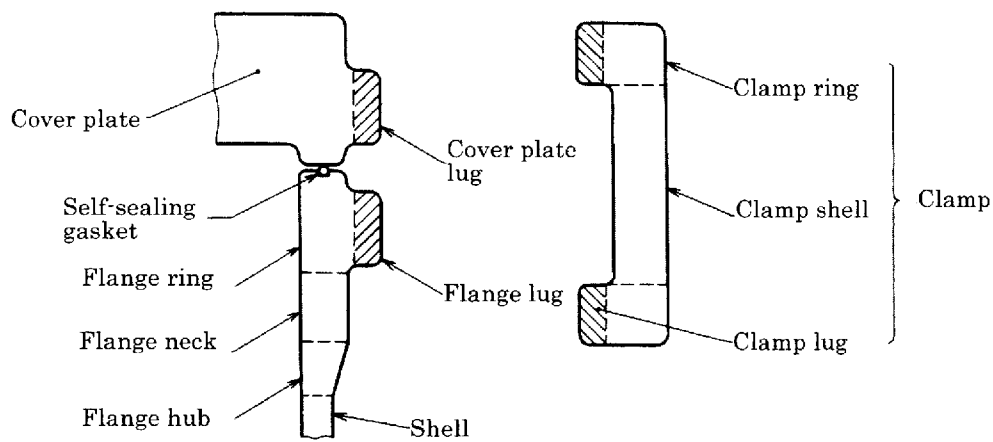


Figure 1 Solid clamp type

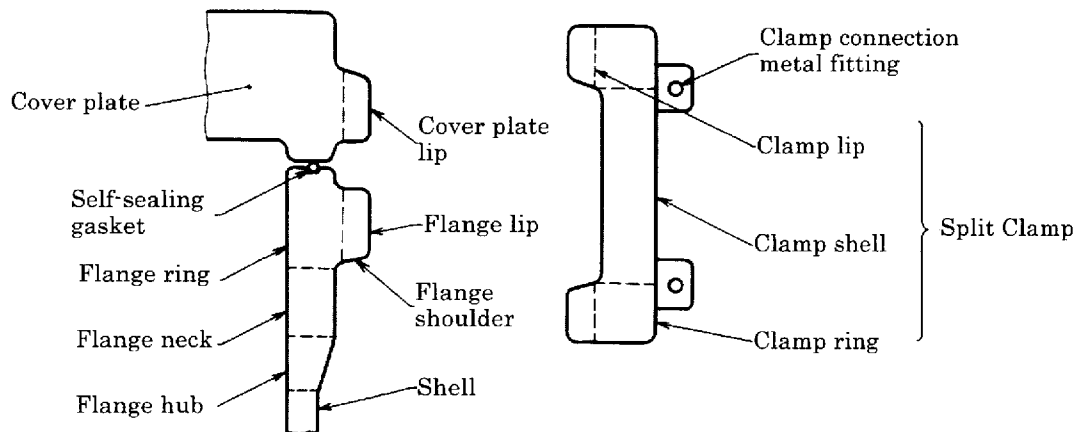


Figure 2 Split clamp type

- b) **Integral type** The integral type shall be the integral type with lugs given in figure 3 and the sectional ring type given in figure 4.

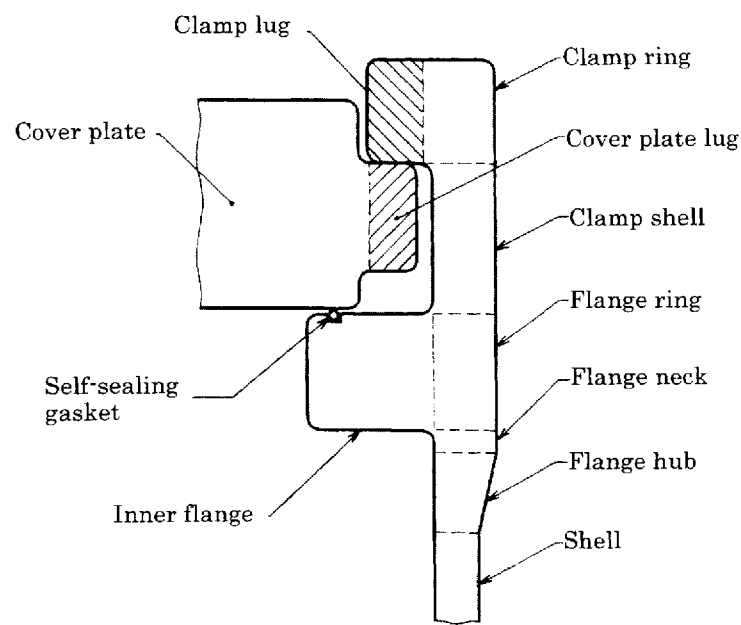


Figure 3 Integral type with lugs

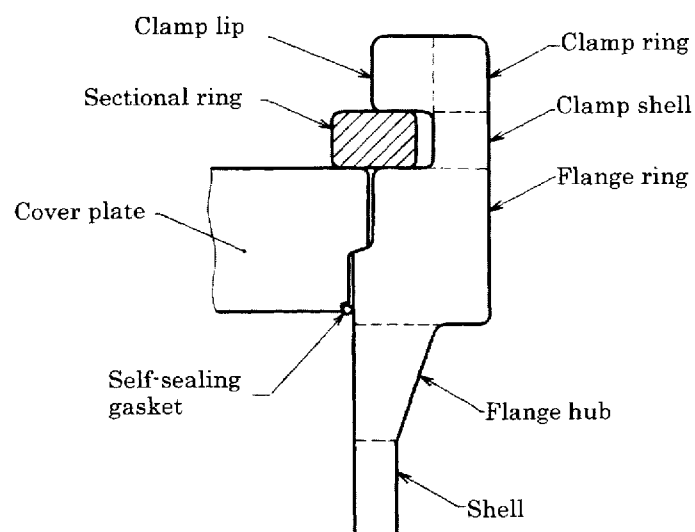


Figure 4 Sectional ring type

- c) **Yoke frame type** The yoke frame type shall be the rectangular type yoke frame given in figure 5 and the obround type yoke frame given in figure 6.

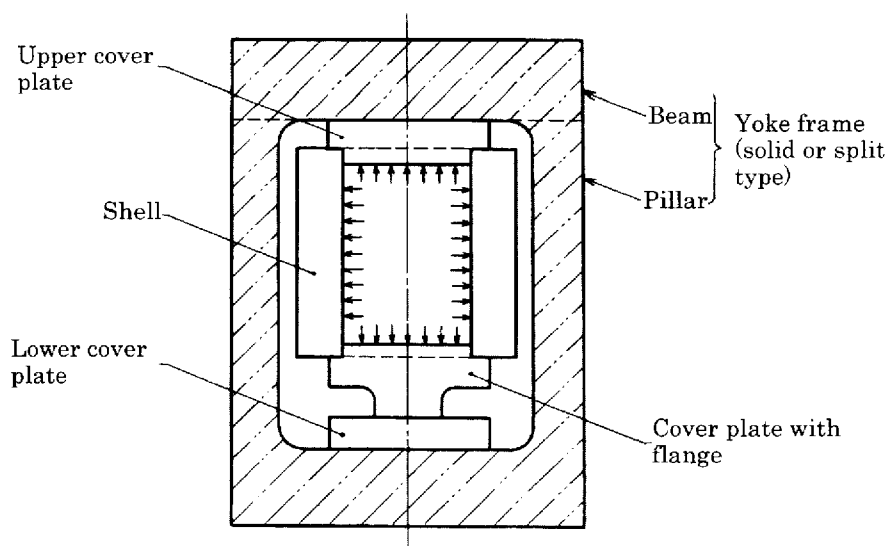


Figure 5 Rectangular type yoke frame

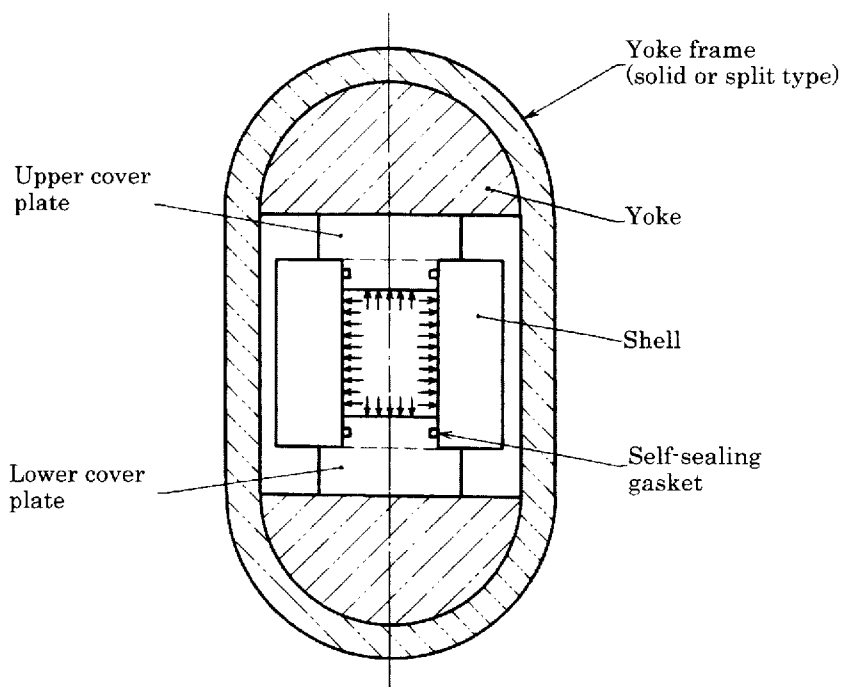


Figure 6 Obround type yoke frame

5 Construction : general

5.1 Materials The materials used for the quick closure shall be in accordance with the requirements of applicable standard, and the following:

- a) The materials shall be limited to iron and steel materials.
- b) The material used for shell flanges and clamps shall be forgings.

- c) The material used for frames may be as agreed between the parties concerned with delivery.

5.2 Design : General The general matters as regards the strength calculation of quick closure shall be in accordance with the following:

- a) The stress of each part of quick closure shall be calculated in accordance with the specifications of clauses 7, 8 and 9, and the values obtained shall be the allowable stress limits shown in clause 10 or under. In this case, the values of allowable tensile stress shall be the values given in attached table 2.1.1. of **JIS B 8265**. However, the values of the allowable tensile stress, when the deformation of the austenitic stainless steel is allowed, shall not be employed.
- b) Since this closure is subjected to the repeated loads owing to its function, the fatigue analysis shall be conducted in accordance with **JIS B 8266** annex 8 by obtaining the peak stress of each stress concentrated part, which corresponds to the sum of primary, secondary and peak stress.

5.3 Test and inspection After machining, the flange lugs, flange lips, cover plate lugs, cover plate lips, clamp lugs, and corners of yoke frame shall be subjected to magnetic particle examination or visible dye penetrant testing to confirm that no defect exists.

6 Common symbols of quick closure The common symbols used for the strength calculations of quick closure for pressure vessels shall be in accordance with the following:

Symbols:

P : design pressure (MPa)

A : outside diameter of flange lug or of cover plate lug (mm) (see figures 7 and 9)

outside diameter of flange lip or of cover plate lip (mm) (see figure 11)

outside diameter of cover plate with lug (mm) (see figures 7 and 13)

B : inside diameter of shell or of flange ring
(mm) (see figures 7, 9, 11, 13, 16 and 19)

C_1 : outside diameter of contact surface of clamp lug with flange lug
(mm) (see figure 9)

outside diameter of contact surface of clamp lip with flange shoulder
(mm) (see figure 11)

C_2 : inside diameter of contact surface of clamp lug with flange lug
 $= C_3 + 2r_L$ (mm) (see figure 9)

inside diameter of contact surface of clamp lip with flange shoulder
(mm) (see figure 11)

C_3 : inside diameter of clamp lug tip end (mm) (see figures 7, 9, and 13)

- inside diameter of clamp lip tip end (mm) (see figures 11 and 19)
- C_g : inside length of clamp (mm) (see figures 7 and 9)
- effective inside length of split clamp (mm) (figure 11)
- C_l : length of clamp lug or length of clamp lip (mm) (see figures 7, 11, 13 and 19)
- C_m : length of clamp lug or moment arm length of clamp lip
 $= C_l - r_l$ (mm) (see figures 7, 11 and 16)
- C_r : length of clamp shell (mm) (see figures 7, 11, 13 and 19)
- C_w : length of clamp (mm) (see figures 7 and 11)
- D_0 : outside diameter of flange neck or diameter of cover plate lug root
 (mm) (see figures 7, 11 and 15)
- G : outside diameter of gasket (mm) (see figures 7, 11, 13 and 19)
- f : stress correction factor of flange hub
 (in accordance with figure 4 of JIS B 8265 annex 3)
- f_1 : dispersion coefficient of load acting on lug
 $= 1.2$ for solid clamp type
 $= 1.1$ for integral type with lugs or sectional ring type
- f_2 : lug width coefficient of clamp $= L_p/L$
- f_3 : lug width coefficient of flange $= L_{pc}/L_c$
- g_0 : thickness of flange hub tip end (mm) (see figures 7, 11, 13 and 19)
- g_1 : thickness of flange neck (mm) (see figures 7, 11, 13 and 19)
- g_2 : length of flange lug (flange lip) or cover plate lug (cover plate lip)
 (mm) (see figures 7 and 13)
- length of flange shoulder (mm) (see figure 11)
- h : length of flange hub part (mm) (see figures 7, 11, 13 and 19)
- h_n : length of flange neck part (mm) (see figures 7 and 11)
- Minimum length of h_n is $0.5 g_1$ or 6 mm, whichever is longer
- h_2 : thickness of flange lug root or of flange lip root (mm) (see figure 7)
- h_3 : thickness at root of cover plate lug or cover plate lip (mm) (see figures 7 and 11)
- h_D : moment arm length given in figure 9 $= \left\{ \frac{C_1 + C_2}{2} - (B + g_1) \right\} / 2$ (mm)
- h_T : moment arm length given in figure 9 $= \frac{(C_1 + C_2) - (B + G)}{4}$ (mm)
- n : number of lugs or number of sectional rings (see figures 8, 14 and 22)
- L : length of clamp lug root (arc length) ($L \geq L_c$) (mm) (see figures 8 and 14)
- L_c : length of flange lug root or cover plate lug root (arc length)

	(mm) (see figures 8 and 14)
L_p : pitch of clamp lug root (arc length)	(mm) (see figures 8 and 14)
L_{pc} : pitch of flange lug root or cover plate lug root (arc length)	(mm) (see figures. 8 and 14)
r_f : inner radius of corner of flange lug and lip, cover plate lug and lip tip	(figures 7, 11 and 15)
r_c : inner radius of clamp corner	(mm) (see figures 7, 11, 13 and 19)
r_h : inner radius of body flange corner or cover plate corner	(mm) (see figures 7, 11, 13, 15 and 19)
r_l : inner radius of clamp lug or clamp lip tip end corner	(mm) (see figures 7, 11, 16 and 19)
T : length of flange ring	(mm) (see figures 7, 11, 13 and 19)
T_0 : thickness of cover plate	(mm) (see figures 7, 11, 13 and 19)
H : total load acting due to internal pressure $= \frac{\pi}{4} G^2 P$	(N) (see figures 9, 16 and 20)
H_D : load acting on flange bore area due to internal pressure $= \frac{\pi}{4} B^2 P$	(N) (see figures 9, 16 and 20)
M_1 : moment generating on connecting surface of clamp ring with clamp shell (per unit peripheral length of clamp shell mean diameter)	(Nmm/mm) (see figures 9, 16 and 20)
M_D : moment due to load acting on flange bore area $= H_D h_D$	(Nmm) (see figures 9 and 20)
M_F : offset moment $= H_D (g_1 - g_0) / 2$	(Nmm) (see figures 9, 14 and 20)
M_H : moment generating on connecting surface of flange ring with flange neck	(Nmm) (see figure 9)
M_0 : total moment acting on flange	(Nmm) (see figures 9, 16 and 20)
$\beta : \sqrt[4]{\frac{12(1-\nu^2)}{B^2 g_1^2}} \div \frac{1.818}{\sqrt{B g_1}}$	(1/mm)
ν : poisson ratio $= 0.3$	
σ_a : allowable tensile stress of material	(N/mm ²)

7 Strength calculation of clamp connection type

7.1 Solid clamp type

- a) **Symbols of dimensions of solid clamp type** Symbols of dimensions of solid clamp type are given in figure 7 and figure 8.

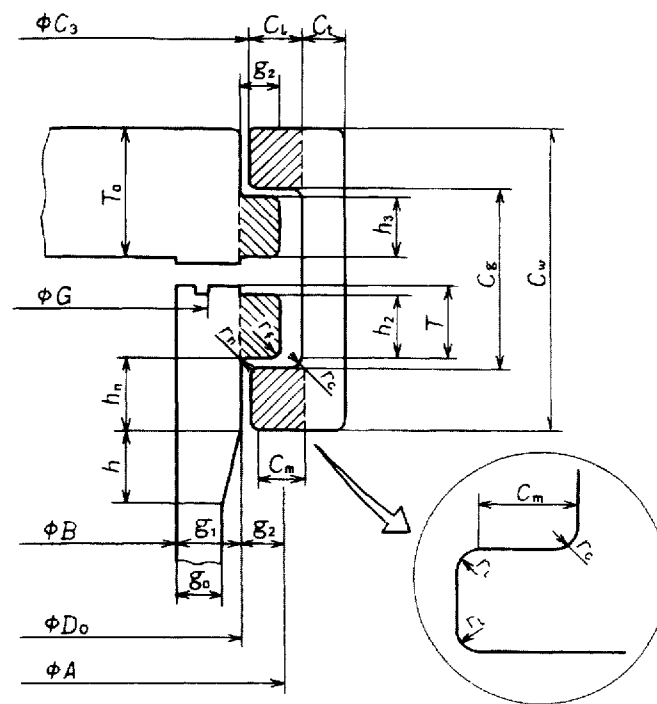


Figure 7 Symbols of dimensions of solid clamp type

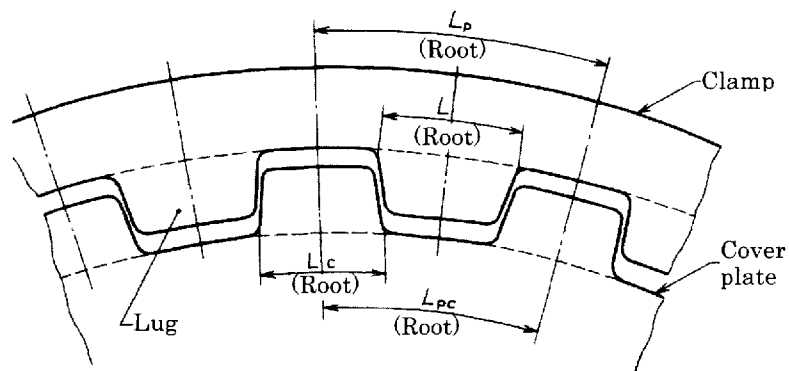


Figure 8 Symbols of dimensions of lug part

- b) **Loading conditions, stress symbols and evaluating positions of solid clamp type**
The loading conditions of solid clamp type are given in figure 9.

In addition, the stress symbols and evaluation positions thereof are given in figure 10.

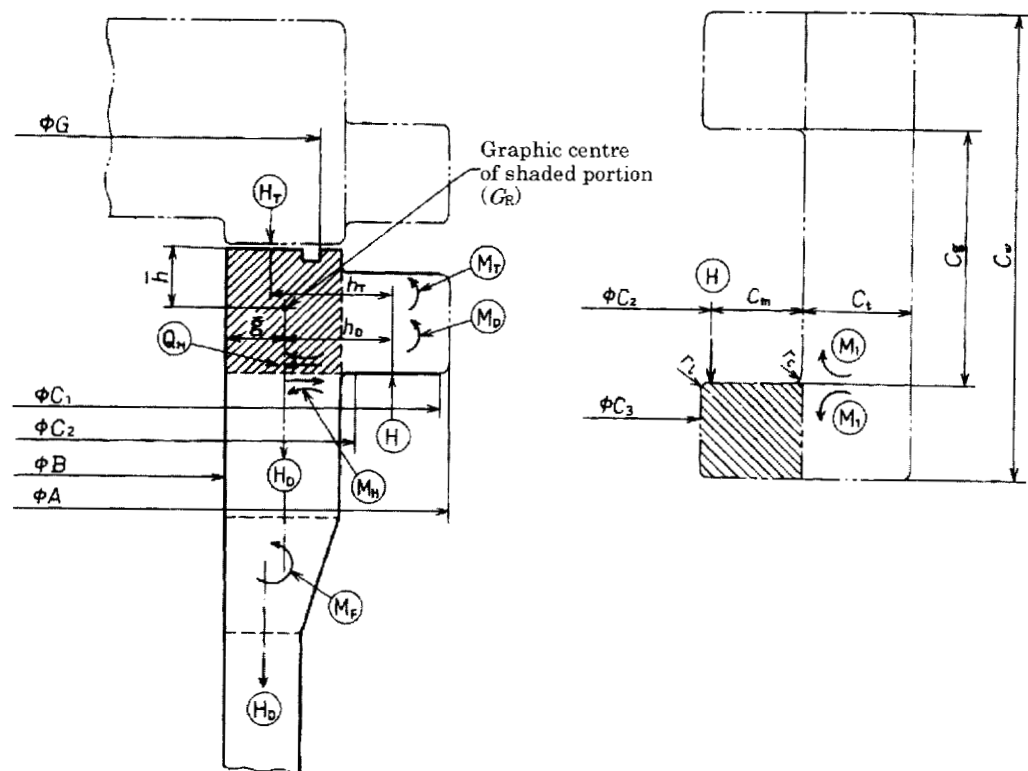


Figure 9 Loading conditions of solid clamp type

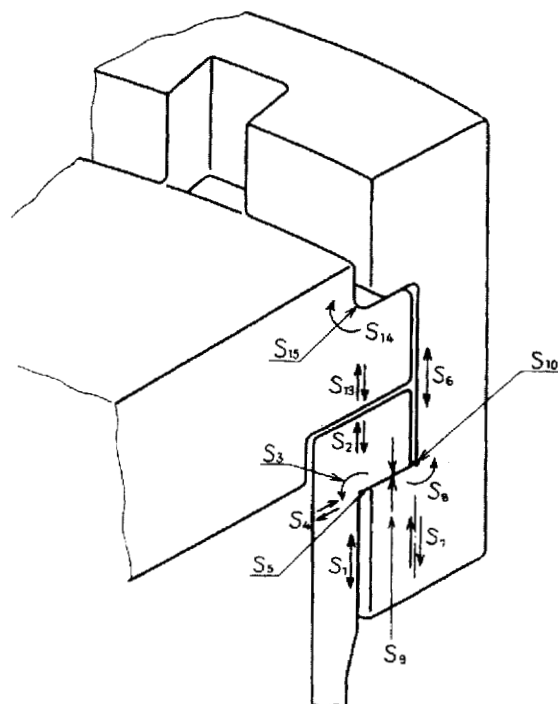


Figure 10 Stress symbols and evaluating positions of solid clamp type

- c) **Meanings of symbols** The meanings of symbols used in the strength calculation of 7.1 shall be in accordance with the common symbols of clause 6 and the following:

H_T : the difference between the total load which acts due to internal pressure and the load generating on the flange bore area

$$= H - H_D = \frac{\pi}{4}(G^2 - B^2)P \quad (\text{N})$$

I_A : the geometrical moment of inertia for the neutral axis parallel to the flange face of flange ring $= \frac{g_1 T^3}{12}$ (mm⁴) (hatching portion of figure 9)

$\bar{g}$: the radial distance from the inside diameter of flange to the graphical centre (G_R) of flange ring $= \frac{g_1}{2}$ (mm) (see figure 9)

$\bar{h}$: the axial distance from the flange surface to the graphical centre (G_R) of flange ring $= \frac{T}{2}$ (mm) (see figure 9)

M_T : the moment due to the difference between the total load due to internal pressure subjected to the flange and the load which subjected to the flange bore area

$$= H_T h_T \quad (\text{Nmm}) \text{ (see figure 9)}$$

Q_H : the shear force generating on the connecting face of the flange ring and flange neck $= \beta M_H \doteq 1.818 M_H / \sqrt{B g_1}$ (N) (see figure 9)

K_c : the stress concentration factor at the corner of flat cover plate lug [see 7.1.4 c) 3)]

K_{BF} : the bending stress concentration factor of flange corner [see 7.1.2 e)]

K_{TF} : the tension stress concentration factor of flange corner [see 7.1.2 e)]

S_{BC} : the bending stress of clamp (N/mm²)

S_{BF} : the bending stress of flange corner (N/mm²)

S_{TC} : the membrane stress in the longitudinal direction of clamp (N/mm²)

S_{TF} : the membrane stress in the longitudinal direction of flange corner (N/mm²)

S_1 : the stress in the longitudinal direction on the outer surface of flange neck (N/mm²)

S_2 : the shear stress in the longitudinal direction of flange lug root (N/mm²)

S_3 : the bending stress at flange lug root (N/mm²)

S_4 : the shear stress in the radial direction which generates at the connecting part of flange ring with flange neck (N/mm²)

S_5 : the maximum stress at flange corner portion (N/mm²)

S_6 : the stress in longitudinal direction of clamp	(N/mm ²)
S_7 : the shear stress at clamp lug root	(N/mm ²)
S_8 : the bending stress at clamp lug root	(N/mm ²)
S_9 : the bearing stress of clamp lug with flange lug	(N/mm ²)
S_{10} : the maximum stress at clamp corner portion	(N/mm ²)
S_{13} : the shear stress at root of flat cover plate lug	(N/mm ²)
S_{14} : the bending stress at root of flat cover plate lug	(N/mm ²)
S_{15} : the maximum stress at corner of flat cover plate lug root	(N/mm ²)

7.1.1 Moment and shear force acting on flange The moment and shear force acting on the flange shall be in accordance with the following:

a) Total moment acting on the flange (M_0)

$$M_0 = M_D + M_T + M_F \quad (\text{Nmm})$$

b) Moment and shear force generated on the connecting surface of the flange ring with flange neck

1) Moment (M_H)

$$M_H = M_0 \left/ \left(1 + \frac{1.818}{\sqrt{B g_1}} \left\{ (T - \bar{h}) + \frac{3.305 I_A}{g_1^2 \left(\frac{B}{2} \bar{g} \right)} \right\} \right) \right. \quad (\text{Nmm})$$

2) Shear force (Q_H)

$$Q_H = 1.818 M_H / \sqrt{B g_1} \quad (\text{N})$$

7.1.2 Stresses of flange ring (flange neck) and flange lug root The stresses of the flange ring (flange neck) and flange lug root shall be calculated by the following formulae, and the results shall be the allowable stress limits defined in clause 10, or under.

a) Stress in the longitudinal direction on outer surface of flange neck (S_1)

$$S_1 = \left\{ \frac{H_D}{\pi g_1 (B + g_1)} + \frac{6 M_H}{\pi g_1^2 (B + g_1)} \right\} f \quad (\text{N/mm}^2)$$

b) Shear stress in the longitudinal direction of flange lug root (S_2)

$$S_2 = \frac{1.5 H}{n L_c h_2} f_1 \quad (\text{N/mm}^2)$$

c) Bending stress of flange lug root (S_3)

$$S_3 = \frac{3 H \left(\frac{C_1 + C_2}{2} - D_0 \right)}{n L_c h_2^2} f_1 \quad (\text{N/mm}^2)$$

- d) Shear stress in the radial direction generating on the connecting surface of flange ring with flange neck (S_4)

$$S_4 = \frac{1.5Q_H}{\pi(B + g_1)g_1} \quad (\text{N/mm}^2)$$

- e) Maximum stress of flange corner (S_5)

$$S_5 = (K_{BF} S_{BF} + K_{TF} S_{TF}) f_1 f_3 \quad (\text{N/mm}^2)$$

where,

$$K_{BF} = 1 + \left\{ \frac{\frac{g_1 + 2g_2}{g_1} - 1}{2 \left(5.37 \frac{g_1 + 2g_2}{g_1} - 4.8 \right)} \left(\frac{g_1}{r_h} \right) \right\}^{0.85}$$

$$K_{TF} = 1 + \left\{ \frac{\frac{g_1 + 2g_2}{g_1} - 1}{4 \left(1.4 \frac{g_1 + 2g_2}{g_1} - 1 \right)} \left(\frac{g_1}{r_h} \right) \right\}^{0.65}$$

$$S_{BF} = \frac{6M_H}{\pi g_1^2 (B + g_1)} \quad (\text{N/mm}^2)$$

$$S_{TF} = \frac{H_D}{\pi g_1 (B + g_1)} \quad (\text{N/mm}^2)$$

7.1.3 Stresses of clamp The stresses of clamp part shall be calculated by the following formulae, and the results shall be the allowable stress limits or under specified in clause 10.

- a) **Stress in the longitudinal direction of clamp** The longitudinal stress of clamp shall be calculated by the formula defined in 1). However, the formula defined in 2) may also be employed.

- 1) Stress in the longitudinal direction of clamp (S_6)

$$S_6 = S_{BC} + S_{TC} \quad (\text{N/mm}^2)$$

where,

$$S_{BC} = \frac{6|M_1|}{C_t^2} \quad (\text{N/mm}^2)$$

$$S_{TC} = \frac{H}{\pi(C_2 + 2C_m + C_t)C_t} \quad (\text{N/mm}^2)$$

$$M_1 = \frac{\frac{H(C_m + C_t/2)}{\pi(C_2 + 2C_m + C_t)}}{\frac{(1 - \nu^2)}{\beta_1(C_2 + 2C_m + C_t)} \left(\frac{C_w - C_g}{2C_t} \right)^3 \log_e \left\{ \frac{C_2 + 2(C_m + C_t)}{C_2 + 2C_m} \right\} - \left\{ 1 + \frac{\beta_1(C_w - C_g)}{4} \right\}} \quad (\text{Nmm/mm})$$

$$\beta_1 = \sqrt[4]{\frac{3(1-\nu^2)}{C_t^2 \left(\frac{C_2 + 2C_m + C_t}{2} \right)^2}} \div \frac{1.818}{\sqrt{C_t(C_2 + 2C_m + C_t)}} \quad (1/\text{mm})$$

2) Stress in the longitudinal direction of clamp (S_6)

$$S_6 = S_{BC} + S_{TC} \quad (\text{N/mm}^2)$$

where,

$$S_{BC} = \frac{6H(C_m + C_t/2)}{\pi(C_2 + 2C_m + C_t)C_t^2} \quad (\text{N/mm}^2)$$

$$S_{TC} = \frac{H}{\pi(C_2 + 2C_m + C_t)C_t} \quad (\text{N/mm}^2)$$

b) Shear stress of clamp lug root (S_7)

$$S_7 = \frac{3f_1H}{nL(C_w - C_g)} \quad (\text{N/mm}^2)$$

c) Bending stress of clamp lug root (S_8)

$$S_8 = \frac{24f_1HC_m}{nL(C_w - C_g)^2} \quad (\text{N/mm}^2)$$

d) Bearing stress of clamp lug with flange lug (S_9)

$$S_9 = \frac{2f_1H}{n(C_1 - C_2)L_c} \quad (\text{N/mm}^2)$$

where, L_c is either L or L_c , whichever is the smaller

e) Maximum stress of clamp corner (S_{10})

$$S_{10} = f_1 f_2 (K_{BC} S_{BC} + K_{TC} S_{TC}) \quad (\text{N/mm}^2)$$

where, K_{BC} : factor of bending stress concentration at clamp corner portion

$$= 1 + \left[\frac{\frac{C_t + 2C_l}{C_t} - 1}{2 \left\{ 5.37 \frac{C_t + 2C_l}{C_t} - 4.8 \right\}} \left(\frac{C_t}{r_c} \right) \right]^{0.85}$$

K_{TC} : factor of tensile stress concentration at clamp corner portion

$$= 1 + \left[\frac{\frac{C_t + 2C_l}{C_t} - 1}{4 \left\{ 1.4 \frac{C_t + 2C_l}{C_t} - 1 \right\}} \left(\frac{C_t}{r_c} \right) \right]^{0.65}$$

7.1.4 Calculation of flat cover plate The strength calculation of flat cover plate of quick closure shall be in accordance with the following:

a) **Thickness of flat cover plate (T_0)**

- 1) Solid clamp type, split clamp type and integral type with lugs (see figures 7, 11 and 13)

$$T_0 = G \sqrt{\frac{0.3P}{\sigma_a} + \frac{1.9H}{\sigma_a \times G^3} \left(\frac{C_1 + C_2}{4} - \frac{G}{2} \right)} \quad (\text{mm})$$

- 2) Sectional ring type (see figure 19)

$$T_0 = (C_3 - 2u) \sqrt{\frac{0.3P}{\sigma_a}} \quad (\text{mm})$$

- b) **When a flat cover plate is provided with an opening** When the flat cover plate is provided with the opening of which diameter is 1/2 or under of the diameter of flat cover plate (excluding the lug and lip part), the thickness of flat cover plate shall be the value obtained by doubling the quantity in root in the formula in 7.1.4 a) or over.

Those of which opening has been reinforced in accordance with 5.7 of annex 2 of JIS B 8265 shall be exempt from this application.

c) **Stress of flat cover plate lug part**

- 1) Shear stress of flat cover plate lug root (S_{13})

$$S_{13} = \frac{1.5 f_1 H}{n L_c h_3} \quad (\text{N/mm}^2)$$

- 2) Bending stress of flat cover plate lug root (S_{14})

$$S_{14} = \frac{3 f_1 H \left(\frac{C_1 + C_2}{2} - D_0 \right)}{n L_c h_3^2} \quad (\text{N/mm}^2)$$

- 3) Peak stress of flat cover plate lug root corner (S_{15})

When lugs are provided on the outer periphery of flat cover plate,

$$S_{15} = K_c S_{14}$$

$$\text{where, } K_c = 0.22 + \frac{1}{\left(\frac{r_h}{h_3} \right)^{0.2} \left(\frac{g_2 - \frac{A}{2} + \frac{C_1 + C_2}{4}}{h_3} \right)^{0.4}}$$

7.2 Split clamp type

- a) **Symbols of dimensions of split clamp type** Symbols of dimensions of split clamp type shall be given in figure 11.