KC#1054

Regarding the hc value of the dry bulk cargo in full-filled condition in which the cargo hold is loaded up to the top of hatch coaming, Ch4/Sec6/1.1.1 of CSR-BC specifies the procedure of calculating the height of dry cargo upper surface(Method 1). Meanwhile a formula for calculating the hc value is given specifically for holds of cylindrical shape (Method 2).

For a typical bulk carrier, upper stools are generally arranged in the cargo hold. The hc values will be different by using the above two procedures. A detailed comparison between the two methods is given as below.

1. Method 1: Calculation of hc using "real volumes"

$hc = h_{HPU} + V_{upper\ part} / A_{lower\ part}$

$V_{upper\ part} = V_{MFULL} - V_{lower\ part}$

V_{MFULL}: Volume of the cargo hold including the volume enclosed by the hatch coaming.

$V_{lower\ part}$: Volume of the cargo hold filled up to the lower intersection of the top side tank and shell or inner side.

$A_{lower\ part}$: Area of the upper surface of $V_{lower\ part}$(red area in Fig. 2).

$V_{upper\ part}$: Volume of the cargo hold part above the lower intersection of the top side tank and shell or inner side, excluding the volume of upper stool.

h_{HPU}: Vertical distance between inner bottom and lower intersection of top side tank and shell or inner side.

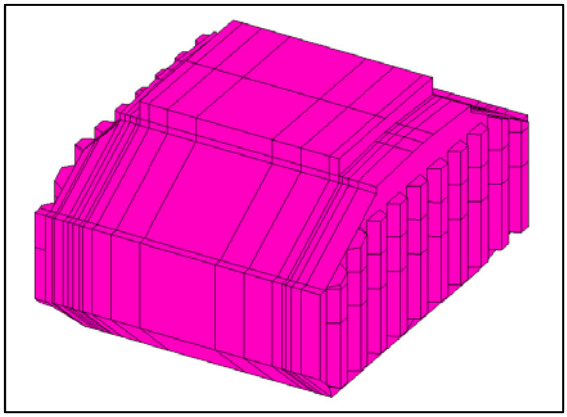


Fig1: V_{MFULL}

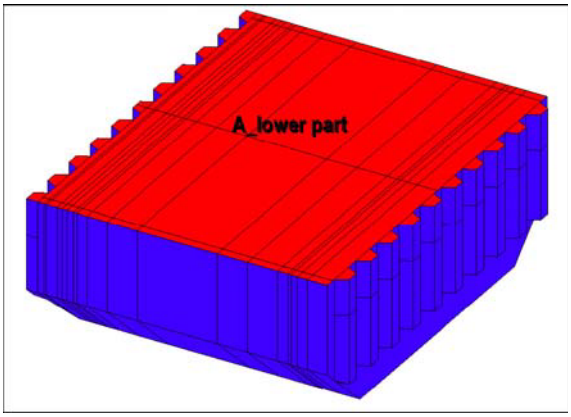


Fig2: $A_{lower\ part}$

2. Method 2: Calculation of hc using "formula"

$hc = h_{HPU} + h_0$

where:

$$h_0 = \frac{S_A}{B_H}$$

$$S_A = S_0 + \frac{V_{HC}}{\ell_H}$$

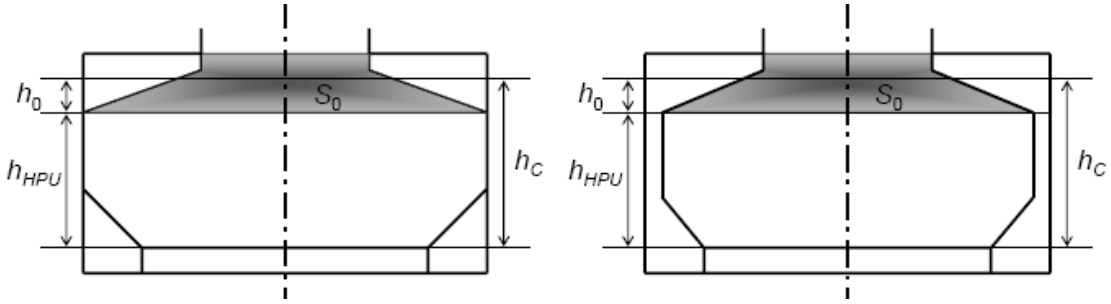
h_{HPU}: Vertical distance, in m, between inner bottom and lower intersection of top side tank and side shell or inner side, as the case may be, as defined in Fig 3.

S_0: Shaded area, in m^2, above the lower intersection of top side tank and side shell or inner side, as the case may be, and up to the upper deck level, as defined in Fig 3.

V_{HC}: Volume, in m^3, enclosed by the hatch coaming.

ℓ_H: Length, in m, of the compartment.

B_H: Mean breadth of the cargo hold, in m.



Single side bulk carrier Double side bulk carrier

Fig3: Definitions of hc, h_0, h_{HPU} and S_0

3. Pressure comparison of the two different methods for hc calculation:

Loading condition:

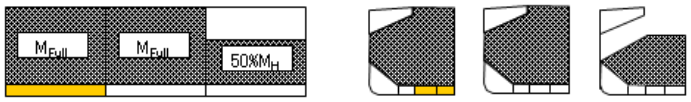


Fig4: Full-filled loading condition

Elements for pressure comparison:

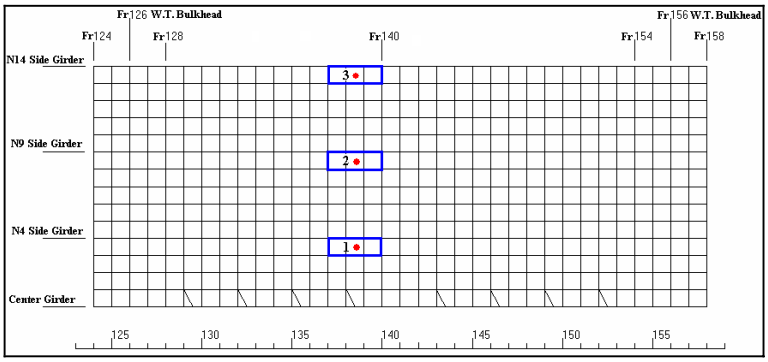


Fig5: Elements for Inner Bottom Plate

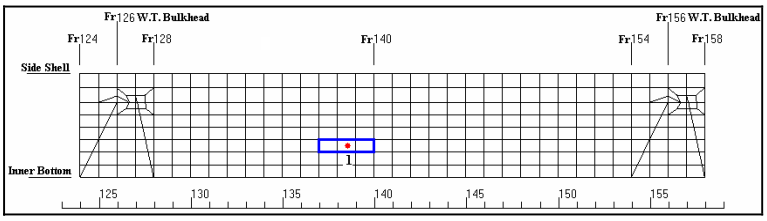


Fig6: Elements for Bilge Hopper Plate

Pressure comparison of the two different methods:

Structural Member	Point ID	Port/Starboard	Pressure(N/mm^2)	
			Method1 (hc=16.024 m)	Method2 (hc=16.212 m)
Inner Bottom Plate	1	P	0.2171	0.2196
		S	0.2128	0.2154
	2	P	0.2190	0.2215
		S	0.2110	0.2135
	3	P	0.2214	0.2239
		S	0.2086	0.2111
Bilge Hopper Plate	1	P	0.1590	0.1609
		S	0.1441	0.1460

4. Cause of the difference

In method 1, the volume of upper stool within cargo hold is deducted from the volume of upper part. The volume is real cargo volume.

In method 2, the volume of upper stool within cargo hold is included in the volume of upper part. Obviously, the volume is approximate to the real cargo volume.

There is no difference between the two methods for the cylindrical shape hold **without Upper Stool.**