

CH6, Sec3, 3.2.4 – Checking criteria

Rule Change:

In addition each compressive stress σ_x and σ_y and the shear stress τ are to comply with the following formulae:

$$\left(\frac{\sigma_x \cdot S}{\kappa_x \cdot R_{eH}} \right)^{a1} \leq 1.0$$

$$\left(\frac{\sigma_y \cdot S}{\kappa_y \cdot R_{eH}} \right)^{a2} \leq 1.0$$

$$\left(\frac{|\tau| \cdot S \cdot \sqrt{3}}{\kappa_\tau \cdot R_{eH}} \right)^{a3} \leq 1.0$$

GL-Answer: In General we consider only the rule defined load cases and loading conditions for the dimensioning of the structure, which are called design-load cases. In case of buckling checks we have to accept, that in reality also load cases exist, they give other load and therefore stress combinations as defined in the design-load-cases. Of course it is guaranteed, that the design-load cases cover the cases with respect of the calculation of the most critical stress-components. In case of buckling we have to consider all possible stress combinations. This is somewhat different and because of that we require, that the buckling strength of the plate has to be high enough to withstand each compressive stress acting alone. This means, that possible stabilizing effects of pressure stresses are neglected. This can be illustrated with the following figures.

In Figure 1 the interaction curve is shown including the Poisson effect. As can be seen there are stress combinations allowable for which the σ_y -component can be greater, than in the case for σ_y is acting alone on the plate. Because of the problem mentioned above, the interaction curve as the base for the rule requirements is limited to stress combinations as shown in figure 2. Please note that this figure is given in Appendix 1 of the Buckling-TB-document. Please refer to “Buckling Strength Assessment of Plates in the IACS Common Structural rules for Bulk Carriers – Sample Applications” , Figure 2.

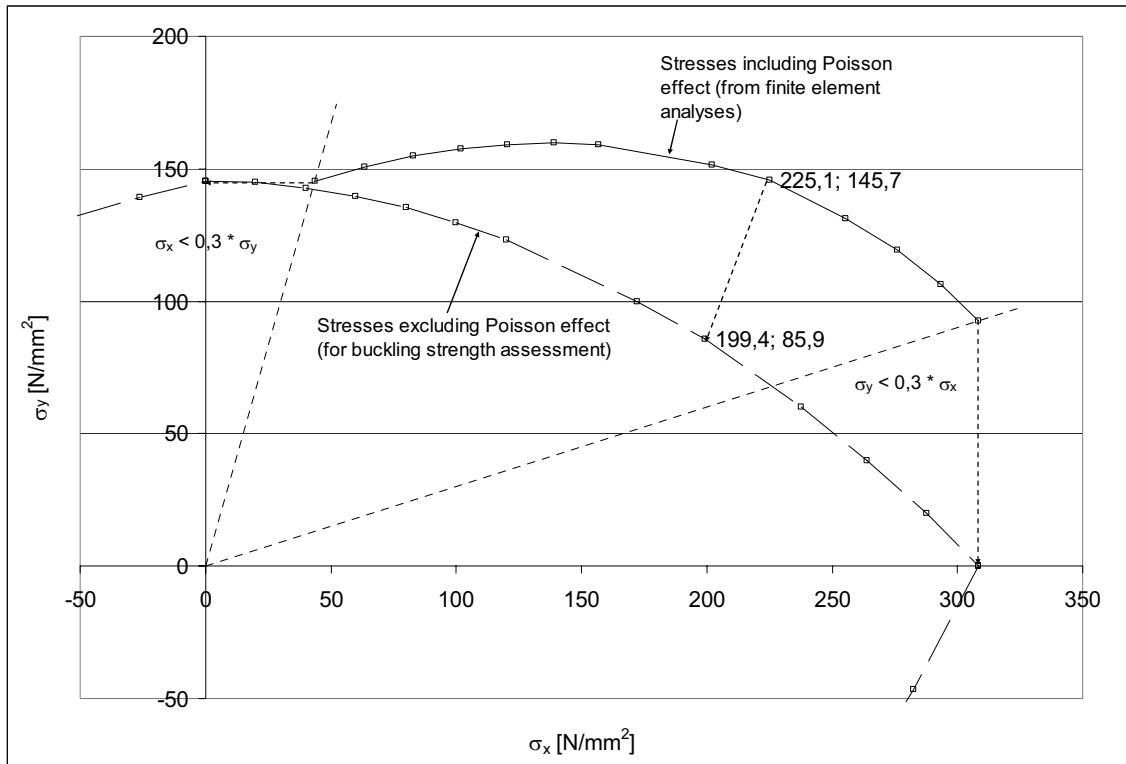


Figure 1: interaction **without** the requirement that the plate has to be stiff enough to withstand each compressive stress alone

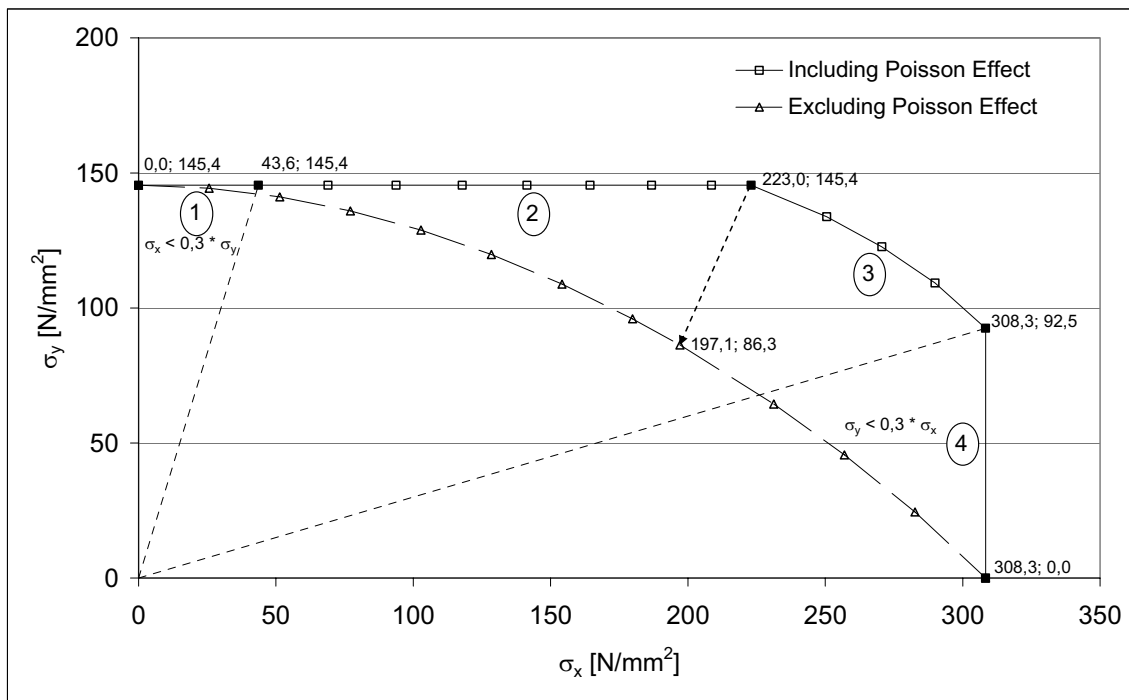


Figure 2: interaction **with** the requirement that the plate has to be stiff enough to withstand each compressive stress alone

Proof of Single Plate Fields

Ramification Study to KC-ID XXX

About the proper usage of FE-stresses in the interaction formula IF (CSR-BC, CH6, Sec3, 3.2.4)

This table gives an overview over the different results of the interaction formula when it is properly used with non-converted FE-stresses (Poisson Effect, CSR-BC, CH6, Sec3, 3.2.3) and when the formula is used wrongly with converted FE-stresses.

Yellow marked single term results indicate that the check of the single acting stress gives a more severe result in comparison to the interaction.

Red marked single term results with properly used stresses indicate that this proper usage gives more severe results. This case would influence the scantlings.

Input Values							Calculated Values						Results of Interaction Formula (IF)					
FE-Stresses			Buck. red. factor			Material	Corrected Stresses		Factors				Single Terms with converted stresses			Proper usage of IF		
σ_x^*	σ_y^*	τ	κ_x	κ_y	κ_t	R_{eH}	σ_x	σ_y	B	e_1	e_2	e_3	1st Term IF	2nd Term IF	IF	1st Term IF	2nd Term IF	IF
200	200	0	1.00	1.00	1.00	235	154	154	1.00	2.00	2.00	2.00	0.43	0.43	0.72	0.72	0.72	0.72
200	150	0	1.00	1.00	1.00	235	170	99	1.00	2.00	2.00	2.00	0.53	0.18	0.59	0.72	0.41	0.59
200	100	0	1.00	1.00	1.00	235	187	44	1.00	2.00	2.00	2.00	0.63	0.03	0.54	0.72	0.18	0.54
200	50	0	1.00	1.00	1.00	235	200	0	1.00	2.00	2.00	2.00	0.72	0.00	0.59	0.72	0.05	0.59
200	0	0	1.00	1.00	1.00	235	200	0	1.00	2.00	2.00	2.00	0.72	0.00	0.72	0.72	0.00	0.72
200	-50	0	1.00	1.00	1.00	235	200	-50	1.00	2.00	2.00	2.00	0.72	0.05	0.95	0.72	0.05	0.95
200	-100	0	1.00	1.00	1.00	235	200	-100	1.00	2.00	2.00	2.00	0.72	0.18	1.27	0.72	0.18	1.27
200	-150	0	1.00	1.00	1.00	235	200	-150	1.00	2.00	2.00	2.00	0.72	0.41	1.67	0.72	0.41	1.67
200	-200	0	1.00	1.00	1.00	235	200	-200	1.00	2.00	2.00	2.00	0.72	0.72	2.17	0.72	0.72	2.17
200	200	0	0.70	1.00	1.00	235	154	154	0.17	1.24	2.00	1.70	0.92	0.43	1.88	1.27	0.72	1.88
200	150	0	0.70	1.00	1.00	235	170	99	0.17	1.24	2.00	1.70	1.04	0.18	1.59	1.27	0.41	1.59
200	100	0	0.70	1.00	1.00	235	187	44	0.17	1.24	2.00	1.70	1.17	0.03	1.39	1.27	0.18	1.39
200	50	0	0.70	1.00	1.00	235	200	0	1.00	1.24	2.00	1.70	1.27	0.00	1.14	1.27	0.05	1.14
200	0	0	0.70	1.00	1.00	235	200	0	1.00	1.24	2.00	1.70	1.27	0.00	1.27	1.27	0.00	1.27
200	-50	0	0.70	1.00	1.00	235	200	-50	1.00	1.24	2.00	1.70	1.27	0.05	1.50	1.27	0.05	1.50
200	-100	0	0.70	1.00	1.00	235	200	-100	1.00	1.24	2.00	1.70	1.27	0.18	1.82	1.27	0.18	1.82
200	-150	0	0.70	1.00	1.00	235	200	-150	1.00	1.24	2.00	1.70	1.27	0.41	2.22	1.27	0.41	2.22
200	-200	0	0.70	1.00	1.00	235	200	-200	1.00	1.24	2.00	1.70	1.27	0.72	2.72	1.27	0.72	2.72
200	200	0	0.40	1.00	1.00	235	154	154	0.01	1.03	2.00	1.40	1.66	0.43	2.89	2.17	0.72	2.89
200	150	0	0.40	1.00	1.00	235	170	99	0.01	1.03	2.00	1.40	1.84	0.18	2.57	2.17	0.41	2.57
200	100	0	0.40	1.00	1.00	235	187	44	0.01	1.03	2.00	1.40	2.02	0.03	2.35	2.17	0.18	2.35
200	50	0	0.40	1.00	1.00	235	200	0	1.00	1.03	2.00	1.40	2.17	0.00	2.03	2.17	0.05	2.03

200	0	0	0.40	1.00	1.00	235	200	0	1.00	1.03	2.00	1.40	2.17	0.00	2.17	2.17	0.00	2.17
200	-50	0	0.40	1.00	1.00	235	200	-50	1.00	1.03	2.00	1.40	2.17	0.05	2.40	2.17	0.05	2.40
200	-100	0	0.40	1.00	1.00	235	200	-100	1.00	1.03	2.00	1.40	2.17	0.18	2.71	2.17	0.18	2.71
200	-150	0	0.40	1.00	1.00	235	200	-150	1.00	1.03	2.00	1.40	2.17	0.41	3.12	2.17	0.41	3.12
200	-200	0	0.40	1.00	1.00	235	200	-200	1.00	1.03	2.00	1.40	2.17	0.72	3.62	2.17	0.72	3.62
200	200	0	0.10	1.00	1.00	235	154	154	0.00	1.00	2.00	1.10	6.55	0.43	9.24	8.51	0.72	9.24
200	150	0	0.10	1.00	1.00	235	170	99	0.00	1.00	2.00	1.10	7.25	0.18	8.92	8.51	0.41	8.92
200	100	0	0.10	1.00	1.00	235	187	44	0.00	1.00	2.00	1.10	7.95	0.03	8.69	8.51	0.18	8.69
200	50	0	0.10	1.00	1.00	235	200	0	1.00	1.00	2.00	1.10	8.51	0.00	8.38	8.51	0.05	8.38
200	0	0	0.10	1.00	1.00	235	200	0	1.00	1.00	2.00	1.10	8.51	0.00	8.51	8.51	0.00	8.51
200	-50	0	0.10	1.00	1.00	235	200	-50	1.00	1.00	2.00	1.10	8.51	0.05	8.74	8.51	0.05	8.74
200	-100	0	0.10	1.00	1.00	235	200	-100	1.00	1.00	2.00	1.10	8.51	0.18	9.06	8.51	0.18	9.06
200	-150	0	0.10	1.00	1.00	235	200	-150	1.00	1.00	2.00	1.10	8.51	0.41	9.46	8.51	0.41	9.46
200	-200	0	0.10	1.00	1.00	235	200	-200	1.00	1.00	2.00	1.10	8.51	0.72	9.96	8.51	0.72	9.96
200	200	0	1.00	0.70	1.00	235	154	154	0.17	2.00	1.24	1.70	0.43	1.88	0.72	0.72	1.27	1.88
200	150	0	1.00	0.70	1.00	235	170	99	0.17	2.00	1.24	1.70	0.53	1.52	0.59	0.72	0.89	1.52
200	100	0	1.00	0.70	1.00	235	187	44	0.17	2.00	1.24	1.70	0.63	1.20	0.54	0.72	0.54	1.20
200	50	0	1.00	0.70	1.00	235	200	0	1.00	2.00	1.24	1.70	0.72	0.77	0.59	0.72	0.23	0.77
200	0	0	1.00	0.70	1.00	235	200	0	1.00	2.00	1.24	1.70	0.72	0.72	0.72	0.72	0.00	0.72
200	-50	0	1.00	0.70	1.00	235	200	-50	1.00	2.00	1.24	1.70	0.72	1.13	0.95	0.72	0.23	1.13
200	-100	0	1.00	0.70	1.00	235	200	-100	1.00	2.00	1.24	1.70	0.72	1.63	1.27	0.72	0.54	1.63
200	-150	0	1.00	0.70	1.00	235	200	-150	1.00	2.00	1.24	1.70	0.72	2.16	1.67	0.72	0.89	2.16
200	-200	0	1.00	0.70	1.00	235	200	-200	1.00	2.00	1.24	1.70	0.72	2.72	2.17	0.72	1.27	2.72
200	200	0	1.00	0.40	1.00	235	154	154	0.01	2.00	1.03	1.40	0.43	1.66	2.89	0.72	2.17	2.89
200	150	0	1.00	0.40	1.00	235	170	99	0.01	2.00	1.03	1.40	0.53	1.05	2.33	0.72	1.61	2.33

200	100	0	1.00	0.40	1.00	235	187	44	0.01	2.00	1.03	1.40	0.63	0.46	1.79	0.72	1.07	1.79
200	50	0	1.00	0.40	1.00	235	200	0	1.00	2.00	1.03	1.40	0.72	0.00	1.07	0.72	0.52	1.07
200	0	0	1.00	0.40	1.00	235	200	0	1.00	2.00	1.03	1.40	0.72	0.00	0.72	0.72	0.00	0.72
200	-50	0	1.00	0.40	1.00	235	200	-50	1.00	2.00	1.03	1.40	0.72	0.52	1.43	0.72	0.52	1.43
200	-100	0	1.00	0.40	1.00	235	200	-100	1.00	2.00	1.03	1.40	0.72	1.07	2.15	0.72	1.07	2.15
200	-150	0	1.00	0.40	1.00	235	200	-150	1.00	2.00	1.03	1.40	0.72	1.61	2.88	0.72	1.61	2.88
200	-200	0	1.00	0.40	1.00	235	200	-200	1.00	2.00	1.03	1.40	0.72	2.17	3.62	0.72	2.17	3.62
200	200	0	1.00	0.10	1.00	235	154	154	0.00	2.00	1.00	1.10	0.43	6.55	9.24	0.72	8.51	9.24
200	150	0	1.00	0.10	1.00	235	170	99	0.00	2.00	1.00	1.10	0.53	4.21	7.11	0.72	6.38	7.11
200	100	0	1.00	0.10	1.00	235	187	44	0.00	2.00	1.00	1.10	0.63	1.87	4.98	0.72	4.26	4.98
200	50	0	1.00	0.10	1.00	235	200	0	1.00	2.00	1.00	1.10	0.72	0.00	2.67	0.72	2.13	2.67
200	0	0	1.00	0.10	1.00	235	200	0	1.00	2.00	1.00	1.10	0.72	0.00	0.72	0.72	0.00	0.72
200	-50	0	1.00	0.10	1.00	235	200	-50	1.00	2.00	1.00	1.10	0.72	2.13	3.03	0.72	2.13	3.03
200	-100	0	1.00	0.10	1.00	235	200	-100	1.00	2.00	1.00	1.10	0.72	4.26	5.34	0.72	4.26	5.34
200	-150	0	1.00	0.10	1.00	235	200	-150	1.00	2.00	1.00	1.10	0.72	6.38	7.65	0.72	6.38	7.65
200	-200	0	1.00	0.10	1.00	235	200	-200	1.00	2.00	1.00	1.10	0.72	8.51	9.96	0.72	8.51	9.96
99	99	0	0.50	1.00	1.00	235	76	76	0.03	1.06	2.00	1.50	0.63	0.11	1.01	0.83	0.18	1.01