Bulker Q&As and CIs on the IACS CSR Knowledge Centre

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
220	8/1.1.3.1	Question	fatigue strength assessment	2006/11/22	The number of members and locations to be assessed is many.We would like to ask you to reduce the number of locations taking into account damage experience and your calculation results.	The members and locations subjected to fatigue strength assessment described in Table 1 of Ch 8 Sec 1 are of the members and locations which the fatigue damage are occurred in the past, even though the number of damages are neglected. Therefore, the fatigue strength assessment should be carried out for the structural details specified in Table 1.	
221	8/2.2.3.1	Question	fillet weld	2006/11/8	There is no category for welded joint of sloped plate and horizontal plate such as hopper knuckle and lower stool in Table 1.Our understanding is as follows, because Frank angle of the weld joint is lesser than fillet weld:"Kf=1.25 for welded joint of sloped plate and horizontal plate"Please confirm the above as soon as possible.	The fatigue notch factor Kf of 1.25 for welded joints of sloped plate and horizontal plate such as hopper knuckle and lower stool can be applied because their welded joints are classified with the load carrying full penetration weld joints as well as butt welded joint. For the non-load carrying full penetration welded joints between plate, the fatigue notch factor Kf may be reduced.	
222	8/2.2.3.2	Question	fatigue damage	2006/11/28	The correction factor for mean stress is very complicated and sensitive to fatigue damage. Please reconsider and revise the factor to meet our engineering sense as soon as possible.	According to the fatigue damage experiences, mean stress effect is the most dominant factor to explain their fatigue damage. Then, the precise procedure to consider the mean stress effect is mentioned in the text. However, to simplify the procedure for the mean stress effect without losing the accuracy of the present fatigue assessment needs much time, careful discusstion and appropriate ramification study. Therefore, for the time being, the text is kept as it is.	
223	8/5.3.1.1	Question	nominal stress range	2006/12/22	We understand that the nominal stress range obtained from this formula is bending stress of the cross deck.Thus the stress occurs in athwartship direction.In general, the major axis is arranged in longitudinal direction to reduce the stress concentration due to hull girder bending moment.Therefore the explanation of ra and rb is not adequate to use the formula properly.For example, ra and rb are inner radius and outer radius, respectively.This rule brings very pessimistic results.In conjunction with the above comment, the rules should be revised to obtain reliable results as soon as possible	The requirement on hatch corner fatigue check will be revised as soon as possible, including a technical background.	

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
250	8/2.2.3.2	Question	hot spot stress range	2006/11/10	Equivalent hot spot stress range (Corrigenda 1) This item seems to be rule change. We would like to know the impact of this rule change.	This revision includes the correction of the factor in the conditional equations and the alternation of the expression. The correction of the factor in the conditional equations is made for the simple error in writing of the factor in the condition that the shakedown in compression stress side is occurred. This condition correspond the case that the large mean stress in compression side is occurred. The effect of this correction on the scantlings of the structural member is very small since the fatigue damage in such case is negligible small. The alternation of the expression is made to clarify the meaning of the conditional equations without changing the conditions.	
251	8/3.2.2.2	Question	FE model	2006/11/10	In Chapter 8 Section 3 / 2.2.2, the calculation of hull girder stresses for the computation of fatigue life by direct strength analysis using superimposition method does not take into account the hull girder bending moments that exist in the FE model due to the local loads. Consequently, some of the hull girder bending stress is considered twice.	The bending moments induced on the FE model by local loads are explicitly taken into account when using superimposition method for yielding and buckling criteria (Cf Ch 7, Sec 2, [2.5.7]), and it seems necessary to proceed in the same way for fatigue. Note: Ch 8, Sec 2, [2.2.2] should make reference to Ch 7, Sec 2, [2.5.7].	
253	Fig 8.5.2	Question	Section modulus	2006/12/20	When calculating section modulus of the cross deck Wq and moment of inertia of the cross deck Iq, how to determine the neutral axis? Is it axis z ? Please clarify it.	IQ and WQ are to be determined about z-axis. In order to clarify the difinition of WQ and IQ, the editorial change will be issued as Corrigenda.	
255	Table 8.4.1	Question	watertight	2006/12/11	In Chapter 8 Section 4, Table 1, some details, in the "watertight" cases seems to be similar (two by two): "3" and "10"; "7" and "12" or "8" and "14". But the values of the stress concentration factors differs from a detail to another. An harmonization of the SCF between these details is needed, in order to apply the right ones.	It is right that the details 3 and 10 (7/12 and 8/14) are very similar for the case "watertight". An harmonization should be very helpful. More generally, each detail should appear only once in the Table with SCF for the two assessed points, and for both cases "watertight" and "non-watertight". It should be considered as a Rule Change	
256	Table 8.4.1	Question	watertight	2006/11/23	In Chapter 8 Section 4, Table 1, the meaning of "watertight" and "non-watertight" in the column "collar plate" is not clear: does it mean that a collar plate is required in any case? Or does it mean that "watertight" is equivalent to a full collar plate and "non-watertight" is equivalent to a partial collar plate?|	A collar plate is not required in all cases."Watertight" means that a full collar plate is fitted, and "non -watertight" means other cases: no collar plate is fitted or a partial collar plate is fitted.It should be better to replace "watertight" by "full collar plate" and "non-watertight" by "other cases".	

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
257	Table 8.4.1	Question	watertight	2006/11/18	In Chapter 8 Section 4, Table 1, for details 1 to 8, stress concentration factors are indicated for both cases 'watertight' and 'weathertight' for one of the assessed point and for case 'watertight' only for the other assessed point. What are the values to consider the stress concentration factors in case 'non-watertight' for this later point?	In the case 'non-watertight', the missing stress concentration factors for one of the two points leads to less severe results in fatigue. That is the reason why the values of the SCF are not indiciated. However, our point of view is to add these values in the Table in order to be coherent.	
258	Table 8.4.1	Question	watertight	2006/12/13	In Chapter 8 Section 4, Table 1, a detail is missing: the one corresponding with detail 1, but without vertical stiffener. What are the values to consider for the stress concentration factors for such a detail?	For a detail corresponding to detail 1, but without vertical stiffener nor bracket, SCFs should be developed.	
259	Table 8.4.1	Question	Aft & Fore	2006/11/23	|In Chapter 8 Section 4, Table 1, the meaning of "Aft" and "Fore" is not clear: does it mean aft and fore ends of the ship, or aft and fore ends of the stiffener considered, or is it only a way to identify both sides of the detail?	"Aft" and "Fore" does not mean aft anf fore part of the ship. They are to be understood as being one side and the other side of the considered detail. It should be better to give a name to the two assessed points, i.e. "Point A" and "Point B", and to modify the schemes accordingly ("A" and "B" instead of "a" anf "f", and delete "Aft" and "Fore".	
277	8/2.2.3.2	Question	conditional equations	2006/11/23	This item seems to be rule change.We would like to know the impact due to this change.	This revision includes the correction of the factor in the conditional equations and the alternation of the expression. The correction of the factor in the conditional equations is made for the simple error in writing of the factor in the condition that the shakedown in compression stress side is occurred. This condition correspond the case that the large mean stress in compression side is occurred. The effect of this correction on the scantlings of the structural member is very small since the fatigue damage in such case is negligible small. The alternation of the expression is made to clarify the meaning of the conditional equations without changing the conditions.	

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
286	8/1.1.3.1 & Table 8.1.1	Question	fatigue strength assessment	2006/12/13	List of locations subject to fatigue strength assessment: a) For ships having length L of 150 m or above, are there any circumstances under which fatigue assessment of the locations listed in the Table can be waived? b) Is each detail to be assessed for location in homogeneous hold, ore hold and ballast hold? (This question is based on actual cases of different Class giving different opinions of the locations requiring fatigue assessment based on actual designs in progress.)	a)No in general. The members and locations subjected to fatigue strength assessment described in Table 1 of Ch 8 Sec 1 are of the members and locations which the fatigue damage are occurred in the past, even though the number of damages are neglected. Therefore, the fatigue strength assessment should be carried out for the structural details specified in Table 1. b)If the arrangement and scantling of the detailed to be assessed in holds are different, each detail should be assessed.	
342 attc	8/4.2.3.6	Question	Transverse BHD	2007/5/22	Relative displacement of transverse BHD. See the attached question.	The relative deflection for double bottom is defined as follows. (1) On the bottom The base line is defined as the line between connecting points of the floors to bottom in way of fore and aft of lower stools. The relative deflection is defined as the deflection of the connecting points of the adjacent floors to bottom measured from the base line. (2) On side shell The case 2 as shown in your attached document is correct.	Y
355	8/5.2.1.1	Question	Parameter correction	2007/3/20	In Chapter 8 Section 5,[2.1.1], the following parameters needs to be more specific: 1) "AQ" is the shear area of the cross deck: does it includes the shear area of all plates and of all ordinary stiffenerd, as shown on Figure 2 ? 2)"bS" is the breadth of the remaining deck strip beside the hatch opening: is it the total breadth on both sides or is it only on one side? If it is the latest case, it should be identical to "b" defined in [3.1.1]. 3) "LC" is the length of the cargo area, it should be noted LC, with "C" as and index.	1) The shear area "AQ" is the effective shear area of the whole section shown in figure 2 with respect to the ship's longitudinal direction. For the deternination of the effective shear area the consideration of only the plate elements is sufficient, and the stiffeners can be neglected. 2) "bs" is only the reamaining deck strip on one side, so it is identical to "b" in [3.1.1] 3) This is an editorial typo: "C" should be as an index in "LC". **Also Included in Corrigenda 5**	

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
359	8/4.2.3.4, 8/4.2.3.5 & 4.3.3.4	Question	Fatigue Calculations	2007/7/2	Please review the below questions related to Fatigue calculations. Q1: Loading conditions and assumptions. Fatigue calculation is performed in the following 4 load condition; Homogenous, Alternate, Ballast and Heavy ballast. The design loading condition for FEM is listed in Ch. 4 App.3. Are these conditions also applicable for prescriptive calculation of stiffener connection according to Ch. 8 Sec. 4? Following differences are fond between Ch.8 Sec. 4 and Ch. 4 App. 3: a.Filling height and density for Homogenous condition. According to Ch. 8 Sec. 4 [2.3.5] the definition of Ch.4 Sec. 6 [1.3] should be applied. That is □ = max(MH/VH,1) and filling to main deck. According to Ch.4App.3 the □ = MH/VH with filling height to main deck. b.Heavy fuel oil tanks(HFO). According to Ch.8 Sec.4 [2.3.4] the filling height of HFO tanks may be taken as "half height of the tank". According to Ch.4 App.3 the HFO tanks is full. Q2: Partially filled ballast tanks. Please advice if all ballast tanks are 100% for the purpose of fatigue calculations? Q3: Still water bending moment We assume the actual still water bending moment in the Loading Manual for the respective loading conditions may be used for the fatigue calculations. Please confirm. Please also clarify which conditions to use, departure, arrival or max./average? Q4: Partially filled Heavy fuel oil tanks. According to Ch. 8 Sec. 4 [2.3.4] the HFO tanks are indicated as half full when calculating CNI factor. Please advise on the following related items: a.The dynamic pressure is calculated according to Ch.4 Sec.6 [2.2.1]. The equation is, as far as we can see, developed based on a full tank. How is this modified to account for filling height? Can this equation be used as is with respect to Ztop and reference point (xB,yB,zB). ? b.Mean stress and still water pressure according to Ch.8 Sec.4 [3.3.4]. The static pressure is calculated according to Ch.4 Sec.6 [2.1]. This still water pressure is assuming PBS = □Lg(zTOP-z+0.5dAP) or □Lg(zTOP-z)+100PPV whichever is greatest. Minimum 25kN/m2. How is this modified to treat partially filled tanks? c.We assume ballast exchange operation is not applicable doing fatigue calculations? Please confirm.	A1 The same loading condition should be applied to both direct strength analysis and prescriptive requirement for fatigue check. (a) rho_c = MH/VH and filling to upper deck may be applied to. (b) Fuel oil is always filled to half the height of FOT. A2: Tanks other than Water Ballast Tanks are considered as being filled at 50%. All Water Ballast Tanks are considered either full or empty. Even though such WBT are intended to be partially filled at the standard loading condition, the partial filling of such tanks is not considered for fatigue check. A3: (a) Yes, actual still water bending moment in the Loading Manual for the respective loading conditions may be used for fatigue strength assessment. (b) The requirement of Chapter 4 Section 3, 2.2.1 mentions that "The design still water bending moment, MSW,H and MSW, S, at any hull transverse section are the maximum still water bending moment calculated, in hogging and sagging condition, respectively, at that hull transverse section for the loading conditions, as defined in 2.1.1.". Therefore, the loading condition is to be used which gives the maximum still water bending moment among the considered loading conditions, i.e., departure, arrival and intermediate conditions specified in Loading Manual. A4: (a) Yes, the equation in Ch.4 Sec.6 [2.2.1] may be used as is, provided; - Liquid surface level at mid-height of the tank may be assumed to remain unchanged relative to tank geometry even when hull motion should occur, - Ztop may be taken as the Z-coordinate, in m, of the Liquid surface level at mid-height of the tank, and - xB, yB and zB may be taken on the Liquid surface level at mid-height of the tank. (b) Ztop may be taken as mentioned in (a). (c) We confirm that ballast exchange operation is not applicable. Please note that Min.25kN/m2 is not applicable to fatigue strength assessment.	

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
375	8/App.1, 1.3.1	Question	Calculation Change	2007/3/9	In Chapter 8, Appendix 1, [1.3.1], the following items needs some clarification: 1) it is understood that the stiffeners are not considered in the calculation of the properties of the cross section. Please confirm? 2) In table 1.4, for symmetric cross section, the parameter "yS" appears in the calculation of "Iz", but is not defined. What is the definition of "yS" in such a case? 3) in table 1.4, for symmetric cross section, it is understood that the parameters "Iwy" and "Iz" which appears in the definition of "zM" are thoseparameters defined just above in the table, and not those defined in the beginning of [1.3.1]. Please confirm? Using twice the same symbol for different definitions is confusing. The same understanding is considered for the parameter "Iwy", used in the definition of "Iw". 4) In Table 1.4, for symmetric cross secton, in the definitionof "Iw", it should be "zM" instead of "zm". 5) Below Table 1.4, it is stated that "S, Iw are to be computed with relation to shear centre M". What are the meaning of "s" and "Iw" in this statement? 6) The formula giving "Deltaw" is not clear. Please explain?	1) That is right: the stiffeners are not to be considered in the calculation of the properties of the cross section. Only the plates are to be considered as "partial area" (defined in [1.1.1]). 2) The parameter "yS" which appears in the calculation of "Iz" for symmetric cross section should be considered equal to zero. By defining it in the same way as for asymmetric cross section, it comes equal to zero, as "Sz" should be equal to zero for such symmetric cross secton. 3) We agree that using twice the same symbol for different definitions is confusing, It should be corrected. However, your understanding is correct: the parameter "Iwy" used in the definition of "Iw" is also the one defined in Table 1.4. 4) That is right, this is a typo: in Table 1.4, for symmetric cross section, in the definition of " Iw", "zm" should be understood as "zM". 5) in the statement "S, Iw are to be computed with relation to shear centre M", "S" is to be understood as being "Sy", "Sz" and "Sw" in the list of formulae at the beginning of [1.3.1], and "Iw" is to be understood as being "Iw", "Iwy" and Iwz". It means that in such expressions the coordinates "yk", "yi", "zk" and "zi" are to be considered also in reltion with the shear centre M. 6) We agree that the formula giving "Delta w" is not clear. The formula should be replaced by: "Delta wi = zM * yi". In order to clarify all symbols in Chapter 8 Appendix 1, we will consider the rule change proposal.the coordinates "yk", "yi", "zk" and "zi" are to be considered also in reltion with the shear centre M.	
385 attc	8/5/3.1.1	Question	Elliptic Corners	2007/3/9	We have some doubts on the correction factor for elliptic corners which appears in the formula of the stress concentration factor in Ch 8, Sec 5, [3.1.1]. We see on the knowledge centre under the answer to question 223 that "The requirement on hatch corner fatigue check will be revised as soon as possible, including a technical background". However, to help for this revision, we would like to ask you to consider the attached document. It shows that some misunderstanding has occurred between "ra" and "rb". Please consider this proposal?	Having considered your attached document, it seems effectively that “ra” and “rb” are not defined correctly. We will consider it at the time of revision of this requirement.	Y

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
386 attc	8/5.3.1.1	Question	Formula "Kgh"	2007/4/25	It seems that there is a mistake in the definition of the term “b” in the formula defining “Kgh”. We think that “b” should be twice the distance from the edge of hatch opening to the ship’s side. Please confirm our interpretation?	It is right, there is a mistake in the formula of “Kgh”. See the technical background attached, in which it is clearly shown on figure 1(b) that “b” should be twice the distance from the edges of hatch opening to the ship’s side. So, the definition of “b” may remains the same as it is, but the formula of “Kgh” should be modified accordingly by replacing the term “b” by “2b”. **Also Included in Corrigenda 5**	Y
452	Table 8.1.1 & 8/1.1.3.1	RCP	fatigue strength assessment	2009/10/6	It is requested from interpretation point of view that the members and locations to be assessed for fatigue strength can be waived with a proviso. It is considered unnecessary to assess fatigue strength by FEM analysis for every location in Table 1 in particular any taken as less significant. Fatigue assessment by FEM should be streamlined to be more practical to focus on critical locations such as lower hopper corners and lower stool connections with inner bottom considering selective cargo holds. The matter leads to a rule change proposal. As a result of our detailed fatigue strength calculation based on simplified method for lower hopper corners and lower stool connections with inner bottom of a panamax bulk carrier, it is found that the fatigue life of these locations is impractically too short. Moreover, it is found that the fatigue life calculated for lower hopper corners in the empty hold is shorter than that in the ballast hold in both cases of bent and welded corners, which is in serious contradiction of the ubiquitous fact of experience. The least fatigue life calculated is only a few years at a lower stool connection in the ore hold for which no way of designing to achieve the prescriptive fatigue life of 25 years could be possible.	We noted your comment and this issue has been addressed in RCN No.3 (issued September 2008).	
603 attc	8/4.2.3.6	CI	Displacement of transverse bulkhead.	2008/4/18	JBP rules Chapter 8,Section 4.2.3.6 Stress due to relative displacement of transverse bulkhead. There are 3 questions: Q1. Is the relative displacement an absolute value or with a sign? Q2. If it is not absolute value, how to decide the sign of them? Q3. We understand that this additional stress is only applied at the transververse bulkhead. This additional stress is not required for the rings adjacent to the transverse bulkhead.	Regarding the requirement in Ch 8, Sec 4, [2.3.6], please find our answers. A1: The relative displacements are not absolute value. They should be calculated with signs (+ or -); A2: The signs of the displacements are decided as per the rules in the attachment; A3: Your understanding is correct and comfirmed.	Y
635 attc	Table 8.4.1	CI	Stress concentration factors	2008/3/26	Regarding the stress concentration factors given in the Rules Chapter 8, Section 4, Table 1, it is understood that where values are given only for connections with watertight collar plates fitted, these are also applicable for connections with non-watertight collar plate or no collar plate fitted. NK Bulletin No.276, 2006 refers. (in Japanese) Please confirm.	Your understanding is correct. We will consider the rule change proposal in order clarify this.	Y

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
688	8/4.2.3.3	Question	Fatigue of stiffener end connection	2008/5/28	Reference is made to Ch.8 Sec.4 [2.3.3] – Fatigue of stiffener end connection – Stress due to wave pressure Design pressure in the formula is CNE x pw. pw should be calculated according to Ch. 4 Sec. 5 [1.3], [1.4], [1.5] Ch. 4 Sec.5 [1.1.1] is generally valid for Section 5. Quote “The total pressure p at any point of the hull, in kN/m2, to be obtained from the following formula is not to be negative: p=pS+pw.” Unquote It is unclear whether or not [1.1.1] is valid for pressure calculation for Ch.8 Sec.4 [2.3.3]. Please note that if no correction to the dynamic pressure is made, the total dynamic pressure for side longitudinals right below the water line is larger than the static pressure at the same location, that is Ps+(CNE x pw) < 0. This is in contraddiction to the general statement in Ch.4 Sec.5 [1.1.1] Q1: Is the statement of Ch.4 Sec. 5 [1.1.1] valid when calculating sea pressure for Ch.8 Sec.4 [2.3.3]? Q2: If yes, it is assumed that Ch.4 Sec.5 [1.6.2] should be used for correcting the dynamic sea pressure. Please advice how to apply [1.6.2]: a.No correction according to [1.6.2] is made for pw when calculating CNE? b.Correction of dynamic pressure according to [1.6.2] for the total dynamic pressure pw = CNE x pw(uncorrected)?	The statement of Ch 4 Sec 5, [1.1.1] is not valid when calculating sea pressure according to Ch 8 Sec 4, [2.3.3]. Becasue Ch 8 Sec 4, [2.3.3] is concerned only the hydrodynamic pressure, not the static pressure. The statement of Ch4 Sec5[1.1.1] is only applicable to the one wave state. When a wave, which has a certain wave height, is acting on the ship's side, wave pressure has to be corrected so as not to generate negative pressure. Therefore the degree of correction is different by the wave height although the correction procedure is the same. The statement of Ch8 Sec4[2.3.3] is introduced to obtain the expected wave condition considering the stochastic nature of wave height so as to evaluate stress range for fatigue assessment.	
742 attc	Table 8.1.1	Question	FEA	2008/10/10	See the attached Question. It has multiple questions, however, for the sake of easy reference, they are grouped as one Question.	A-1 Structural members can be evaluated by the simplified method according to the specification in Ch 7 Sec 4 [3.3] if applicable, except for the following members: hold frames of single side bulk carriers, connections between corrugations and stools and ordinary stiffeners in double side space at the connection of transverse stiffeners with stringer or similar. Where the fatigue assessment is carried out by the very fine mesh FEA, all cargo holds should be evaluated. If the structural details in cargo holds other than heavy ballast hold are the same as those in heavy ballast hold and the evaluated results of those in heavy ballast hold are satisfactory, the very fine FEA for cargo holds other than heavy ballast hold can be omitted. A-2 The transverse BHD connection with vertical lower stool and upper stool as well as sloping ones should be checked. A-3. Only representative locations should be checked.	Y

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
743	Figure 8.5.2	Question	Co-ordinate "Y"	2008/7/2	Ch 8 Sec 5 Figure 2 indicates coordinates. Is the co-ordinate "Y" typo? Should it be "X" ? .	Yes, it is typo. We will consider a rule change.	
812	8/4.2.3.2	Question	Stress concentration factors	2009/3/3	Geometrical stress concentration factor for stress due to lateral pressure, K_gl, is permitted to be evaluated directly by FEM according to Ch8 Sec4, 2.3.3. However, no indications of direct evaluation by FEM are found in the definition of geometrical stress concentration factor for stress due to hull girder moments, K_gh, in Ch8 Sec4, 2.3.2. Please confirm whether geometrical stress concentration factor for stress due to hull girder moments, K_gh, can be evaluated directly by FEM.	The geometrical stress concentration factor for stress due to hull girder moments, K_gh is also be able to evaluated directly by FEM. This is included in RCP 4 which has been reviewed according to PR 32.	
854	8/1.1.3.1 & Table 8.1.1	Question	Primary Support Members	2009/3/10	Table 1 of Ch8, Sec1 defines the members and locations to be analysed in fatigue assessments. Each mentioned connection of primary supporting members is analysed in only one direction. We see the necessity to evaluate a connection from both sides. This question focus' on the connection of inner bottom and lower stool.. Summary of experience with fatigue assessment of heavy ballast cargo holds: + The connection of the inner bottom to the vertical/sloping plate of the lower stool is the most critical loaction + The deformation of the double bottom and the transverse bulkhead expand this welding connection due the large internal dynamic pressures . + The global bending stress plays not a dominant role. Stress ranges of the inner bottom and the stool plating are of a comparable size + Typically the initial calculated damages of the inner bottom AND the stool plate are considerably larger than 1. + Counter measures in one member, e.g inserted plates in inner bootom, decrease the damage of this member, but increase the damage of the other member. As an example, the reduction of the damage of the inner bottom from 4 to 1 may increase the damage of the sloping plate up to 6 or more. The deformation and stresses of the considered structure and the damage results indicate clearly that this fatigue problem is a 3D-problem, where measures in one member directly affects the other member. If we follow the definition of members, to be assessed (Table 1), only the inner bottom need to comply with the fatigue requirements, whatever the calculated damage of the stool plating is. It seems, there are two options: 1) Assess the inner bottom - lower stool connection from both sides. 2) Assess only the inner bottom In case of option 1, we need a modification of the table and we need an instruction, how to deal with approved vessels (MOU, TOCA), where no fatigue assessment have been performed for the stool plating. In case of option 2, it has to be demonstrated, why the damage results of the lower stool plating can be neglected.	~~This is already under discussion at the Hull Panel. The conclusions will be endorsed by PT1.~~ UPDATED ANSWER AGREED 11 SEPT 2009: "Regarding Tab 1 in Ch 8, Sec 1 of CSR-BC, the intent at the time of development of the CSR-BC was not to check the inner bottom only, but the whole connection of inner bottom with sloping and/or vertical plate of lower stool, which includes all the plates. The whole connection means the connection of plating members of inner bottom, side of lower stool, girders and floors in DB and diaphragms in lower stool. In addition, it is to be noted that, when making fatigue assessment of such connection, if fatigue problems are found in any of the above plating members, then reinforcements are to be considered for all the concerned plating members. It means that Table 1 should be understood as considering all the plating members involved in the inner bottom/lower stool connection and not only the inner bottom plating. Table 1 will be modified accordingly at a future date."	

KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer	Attach ment
858	8/2.3.2.1	Question	shape parameter	2009/2/11	In CSR BC Ch.8 Sec.2 [3.2.1], the Weibull shape parameter is taken to 1.0. In CSR OT App. C/2.4.1.2, this parameter is a linear function of the rule length L. Using in CSR BC the same definition of Weibull shape parameter as in CSR OT leads to longer fatigue life duration. As the approach used in CSR OT is also used in BV rules and in other societies, it is therefore requested to reconsider the value of in 1.0 for this parameter in CSR BC.	Originally, the Weibull shape parameter, which is the function of L, was defined for the wave bending moment in the IACS Recommendation No.56 in 1999. Strictly, it depends on the RAO of the object member and considered load environments. In the CSR-B, the Weibull shape parameter was set as 1.0 for the simplification and the effect of such treatment is confirmed being small. The point you mentioned should be the harmonization issue and will be discussed in the forthcoming harmonization team on fatigue.	
875 attc	Table 8.2.2	Question	fatigue strength	2009/9/3	In practice, there are some bulk carriers without heavy ballast condition. How is fatigue strength checked? Especially, how is the coefficient α_j determined which is defined in Ch8, /Sec 2, /Table 2? Is it practical to incorporate α_j in heavy ballast condition into that in normal ballast condition as the following table (as attached)?	Normal ballast condition and heavy ballast condition are required for all vessels with CSR Bulk Carrier notation for providing sufficient draught and trim to prevent damages during navigation in Ch.4 Sec.7 [2.2.1]. In case that a bulk carrier does not have a ballast hold and has only one loading condition carrying ballast water and that the loading condition complies with the both requirements of normal ballast condition and heavy ballast condition in Ch.4 Sec.7 [2.2.1], the loading condition may be treated as normal ballast condition and heavy ballast condition stipulated in Ch.8 Sec.2, Table 2. Coefficient alpha_j in Ch.8 Sec.2, Table 2 should be applied accordingly.	Y
999 attc	8/4.2.3.4	Question	Calculation of stress due to liquid pressure		With respect to Ch.8 Sec.4 [2.3.4] 1. Please specify the definition of the tank top longitudinals in the sentence "… no inertial pressure is considered for the tank top longitudinals…". 2. When calculate the inertial liquid pressure pBW,ij(k),SF for full-filled tank or half-filled tanker, the coordinates of the calculation point taken at the liquid surface should be clarified.	A1 "the tank top longitudinals" in Ch.8/Sec.4/[2.3.4] mean the longitudinals on the top structure of the tank. A2 For the half-filled tanker, when calculating the inertial liquid pressure pBW,ij(k), z=z_SF, y=y coordinate of the calculation point of the longitudinal stiffener. xB, yB and zB are considered in A4 of KC #359	Y

KC#342

Gil-Yong Han

From: Johnston, Alex [Alex.Johnston@lr.org]

Sent: 08 January 2007 12:20

To: Johnston, Alex

Subject: FW: CSR-BC Relative displacement of transverse bulkhead

1. Could you forward our question below to IACS PT with respect to JBP Ch 8 Sec 4 2.3.6 for fatigue analysis of longitudinals in way of T.BHD.

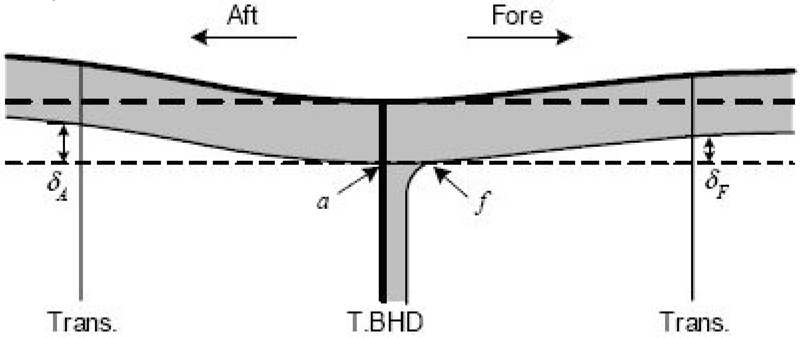


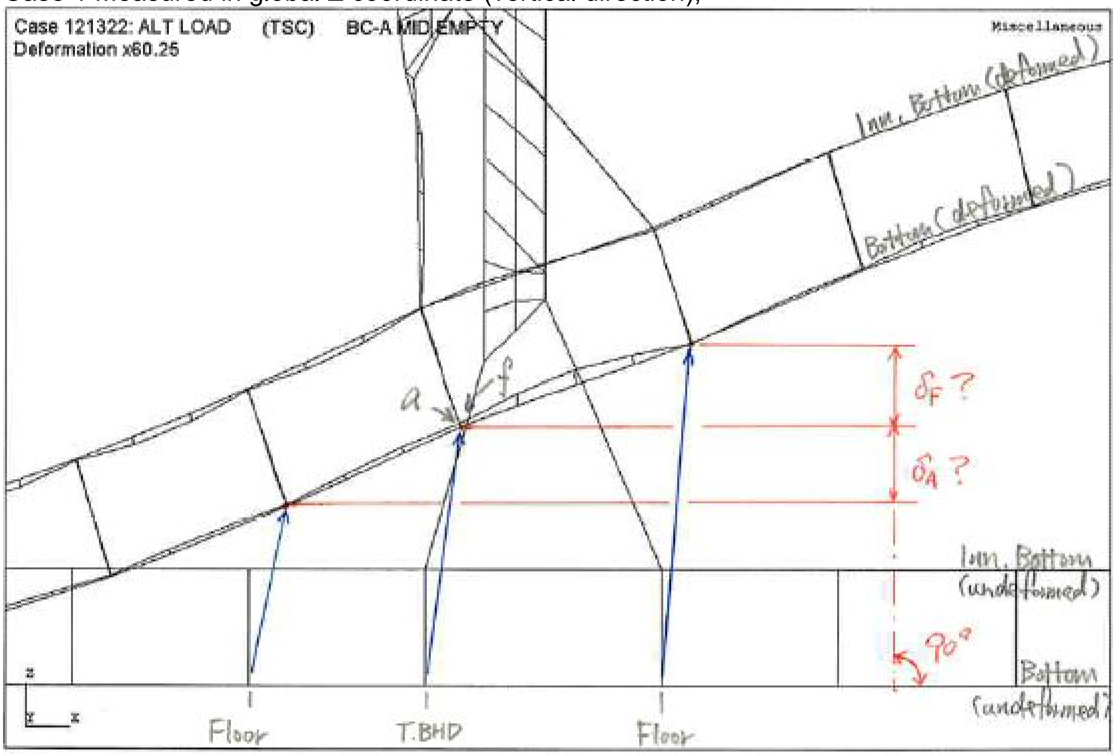
Figure 3: Relative displacement between the transverse bulkhead and the transverse web or floor

2. Relative displacement δ_A, δ_F;

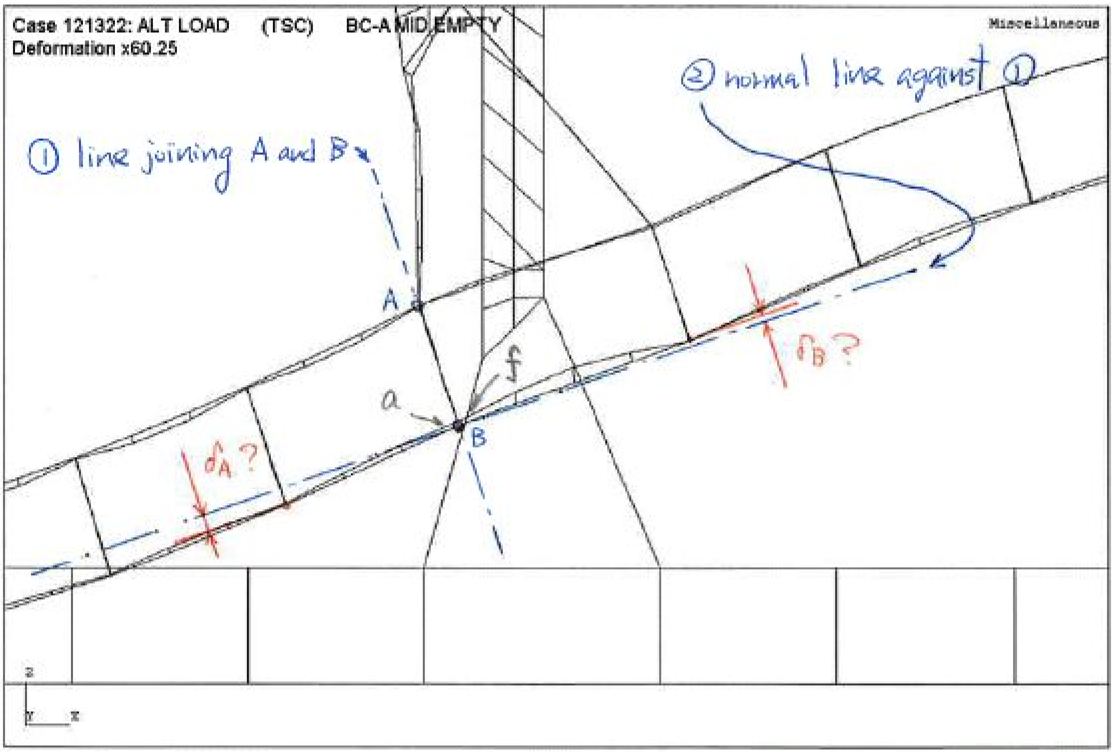
Example displacement in alternate condition is shown below with undeformed shape. We have considered how to treat this relative displacement and some ideas are illustrated. Could you confirm which interpretation (Case 1 ~ 3) is correct?

2.1. On bottom shell;

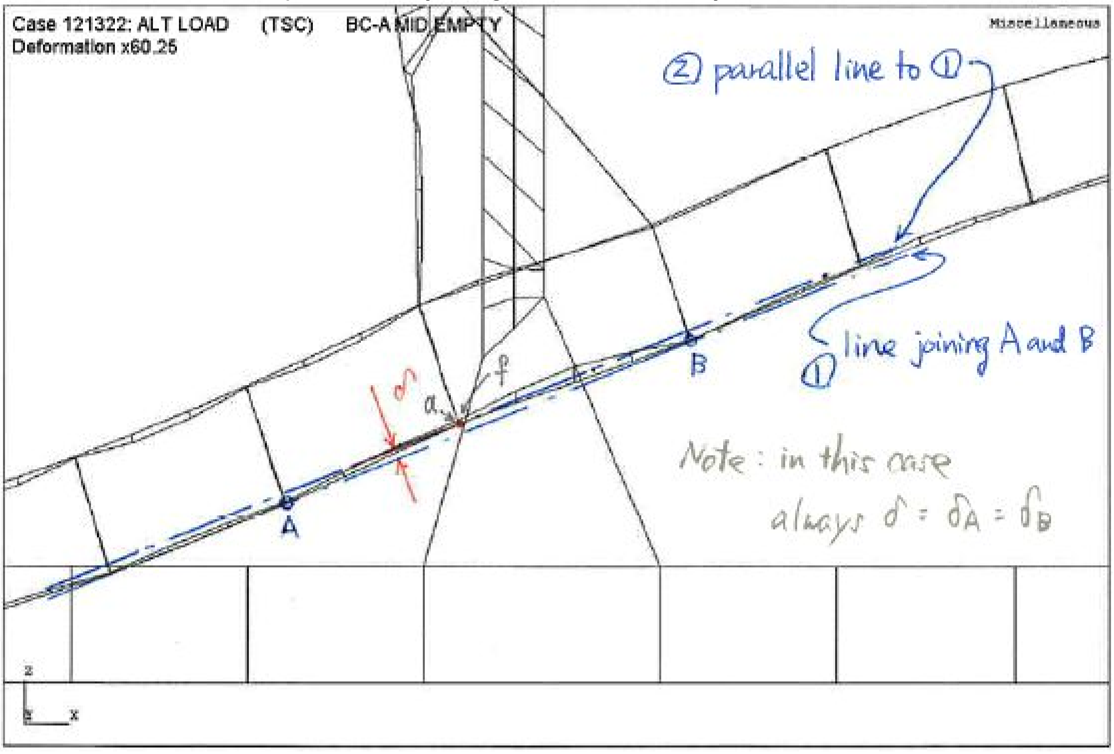
Case 1 Measured in global Z coordinate (vertical direction);



Case 2; Measured from parallel line at the location considered;

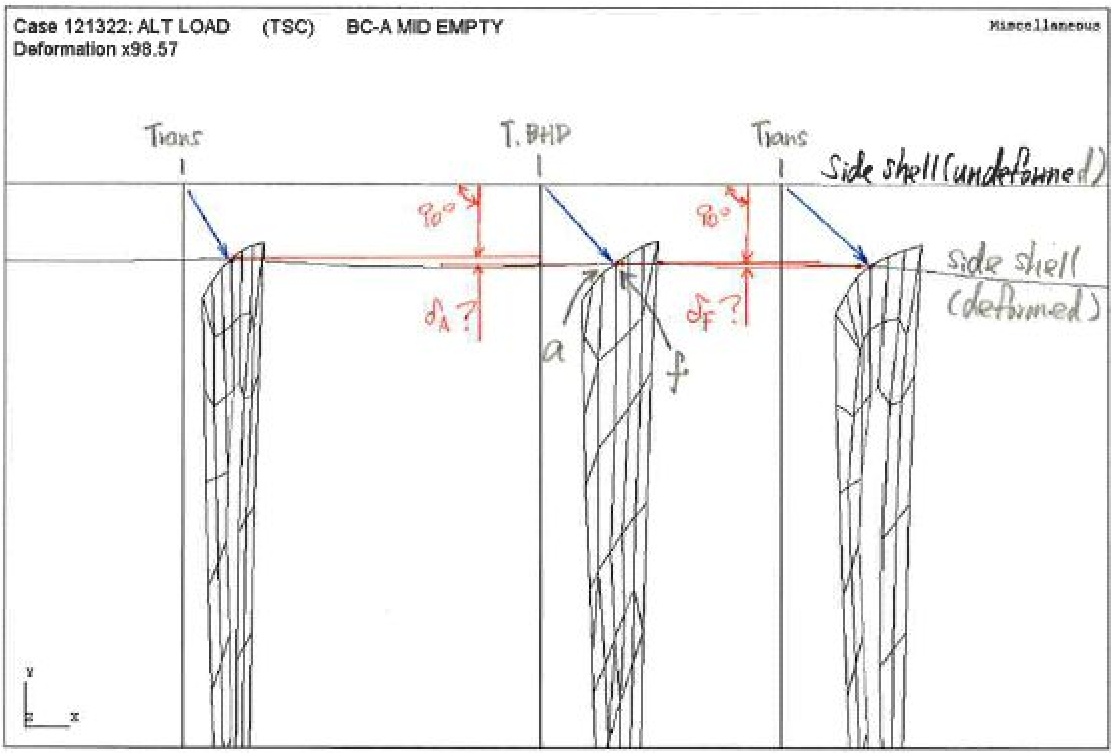


Case 3; Measured from parallel line joining intersection of adjacent floors;

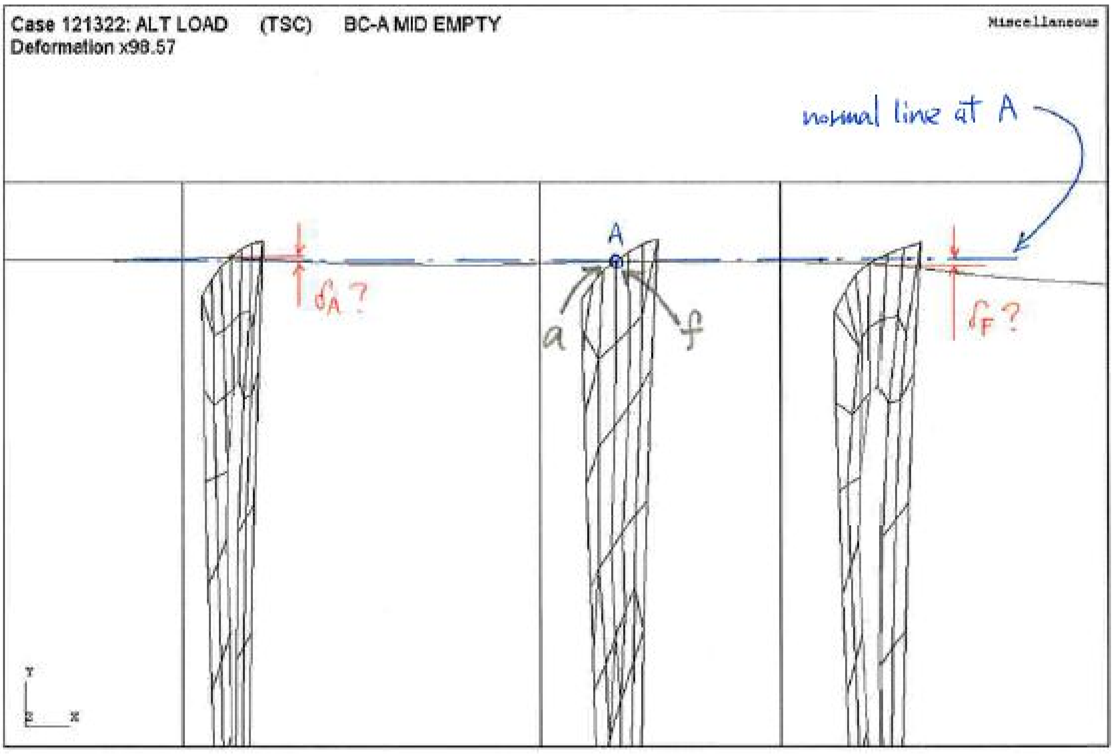


2.2. On side shell;

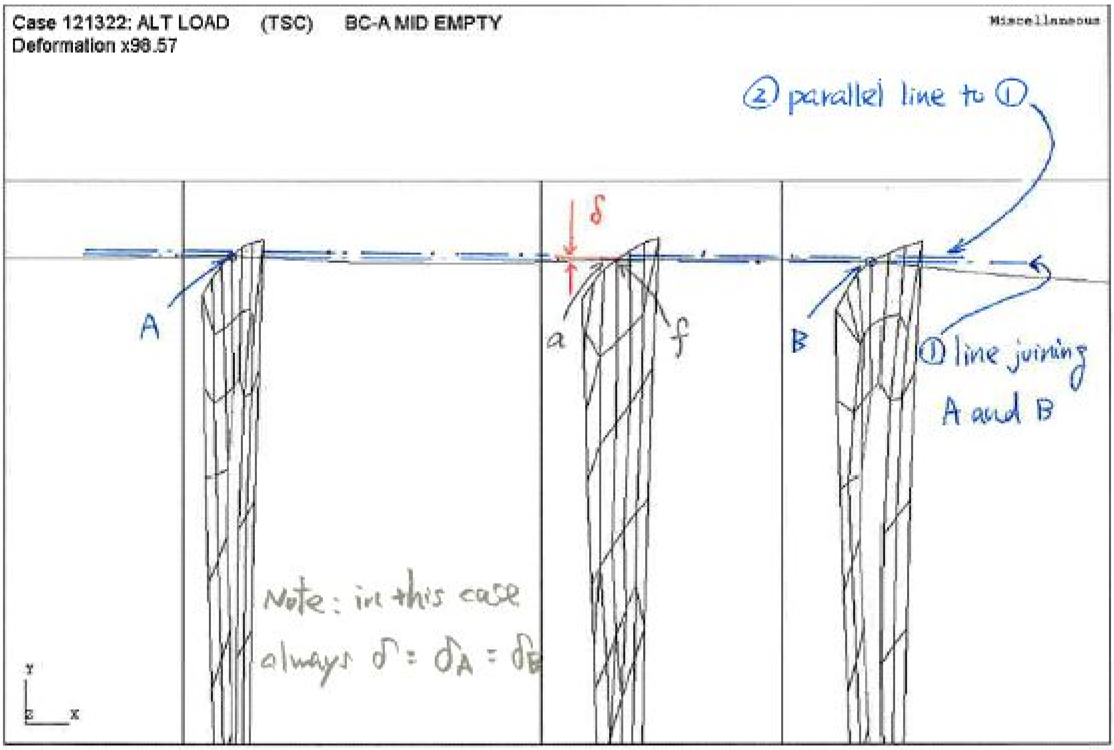
Case 1 Measured in global Y coordinate (transverse direction);



Case 2 Measured from normal line at the location considered;
However, it seems difficult to make the normal line as there are no connecting point such as inner bottom as shown above.



Case 3 Measured from parallel line joining intersection of adjacent transverse webs;



3. This interpretation is urgently requested .

We very much appreciate your kind support,

Best Regards,

A Fukushima
Surveyor
Hull Structures Group
Yokohama Design Support & Plan Approval Department (YDSPAD)
Lloyd’s Register Asia Tel No. +81 (0) 45 682 5270 Fax No. +81 (0) 45 682 5279

KC#385

COMMON STRUCTURAL RULES FOR
BULK CARRIERS

Stress concentration factor for the hatch corners

Doubts in the CSR bulk formula (K_{gh})

COMMON STRUCTURAL RULES FOR
BULK CARRIERS

Chapter 8 - Fatigue check of structural details

Section 5 – STRESS ASSESSMENT OF HATCH CORNERS

3. Hot spot stress

3.1 Hot spot stress range

3.1.1

The hot spot stress range, in N/mm^2, is to be obtained from the following formula:

$$\Delta\sigma_W = K_{gh} \cdot \Delta\sigma_{WT}$$

where:

K_{gh} : Stress concentration factor for the hatch corner, taken equal to:

$$K_{gh} = \frac{r_a + 2r_b}{3r_a}\left[1 + \left(\frac{b}{1.23\ell_{CD} + 0.8b}\frac{0.22\ell_{CD}}{r_a}\right)^{0.65}\right]$$, to be taken not less than 1.0

r_a : Radius, in m, in major axis

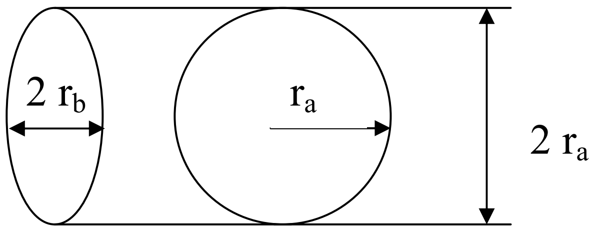
r_b : Radius, in m, in minor axis (if the shape of corner is a circular arc, r_b is to be equal to r_a)

ℓ_{CD} : Length of cross deck, in m, in longitudinal direction

b : Distance, in m, from the edge of hatch opening to the ship's side.

Correction factor for elliptic corners

In the bulk formula, r_a is used for rounded corners (the radius in major axis) as a basis for elliptic corners. They attribute a correction factor to take into account the influence of elliptic shape.
Here is the equivalence between the two shapes:



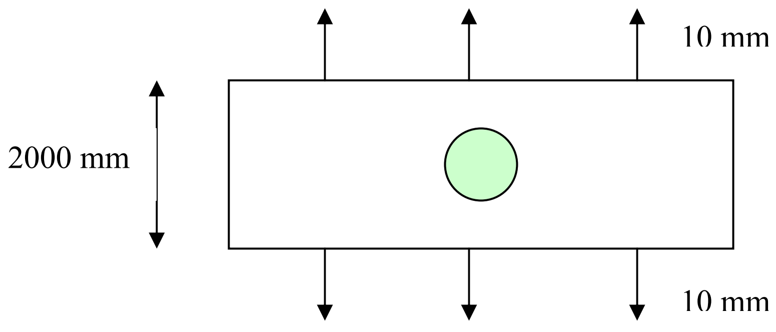
with the following correction factor to apply to get the elliptic stress concentration factor from the rounded one:

$$f_c = \frac{1}{3} + \frac{2r_b}{3r_a}$$

Here follow the original text describing the correction factor:

> *This correction factor gives the ratio of stress concentration for the tension of an infinite width thin element with an elliptic hole to that with a circular hole. In this equation, r_a denotes the radius in major axis and r_b denotes the radius in minor axis. This correction factor can be applied to the stress concentration factor for the fillet shoulder with circular arc shape of radius r_a.*

We test the correction factor with ANSYS 9.0 finite element software. We used shell elements of 10 mm thickness. We model plates of 2 by 6 meters with holes in the middle and impose displacements of 20 mm in the small direction as shown in the figure below. We use a 206000 MPa Young modulus and a 0.3 Poisson ratio.

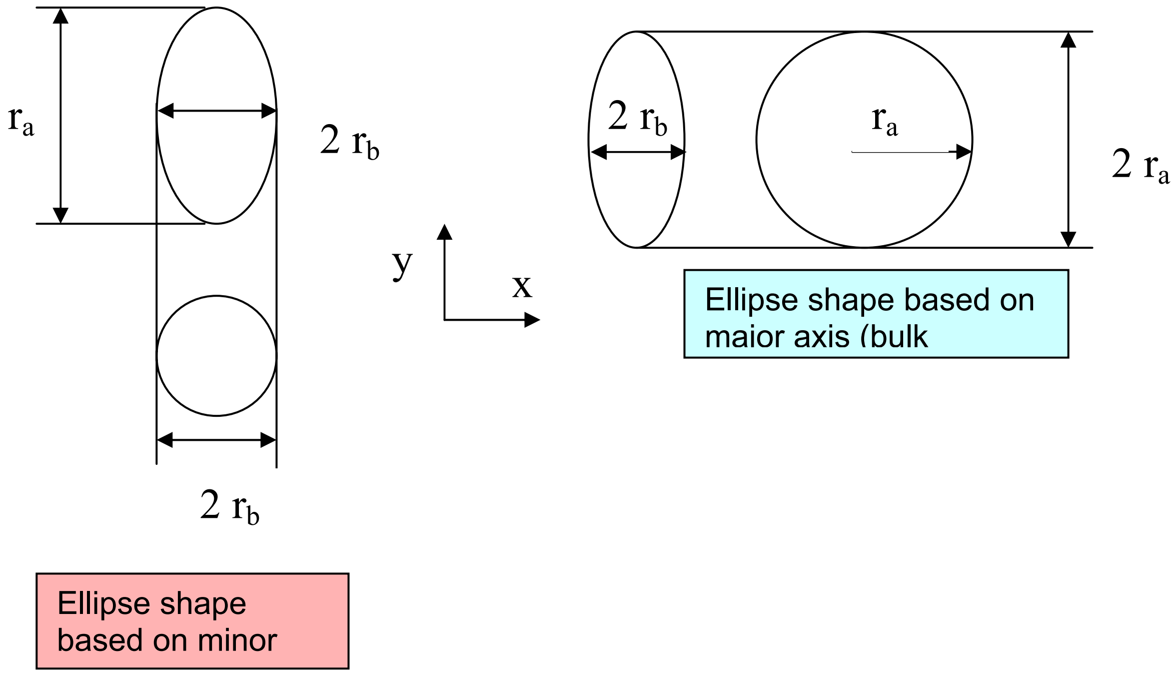


We compare six different shapes to the circular one.

Dimensions of the compared ellipses

Shape	Arm length in x axis	Arm length in y axis
Circular hole	200	200
Ellipse 1	50	200
Ellipse 2	75	200
Ellipse 3	100	200
Ellipse 4	200	250
Ellipse 5	200	300
Ellipse 6	200	400

Ellipse shapes 4, 5 and 6 are other kind of ellipse shape that those used for bulk formula. The reference axis is the minor one.



Measures

- Mean stress

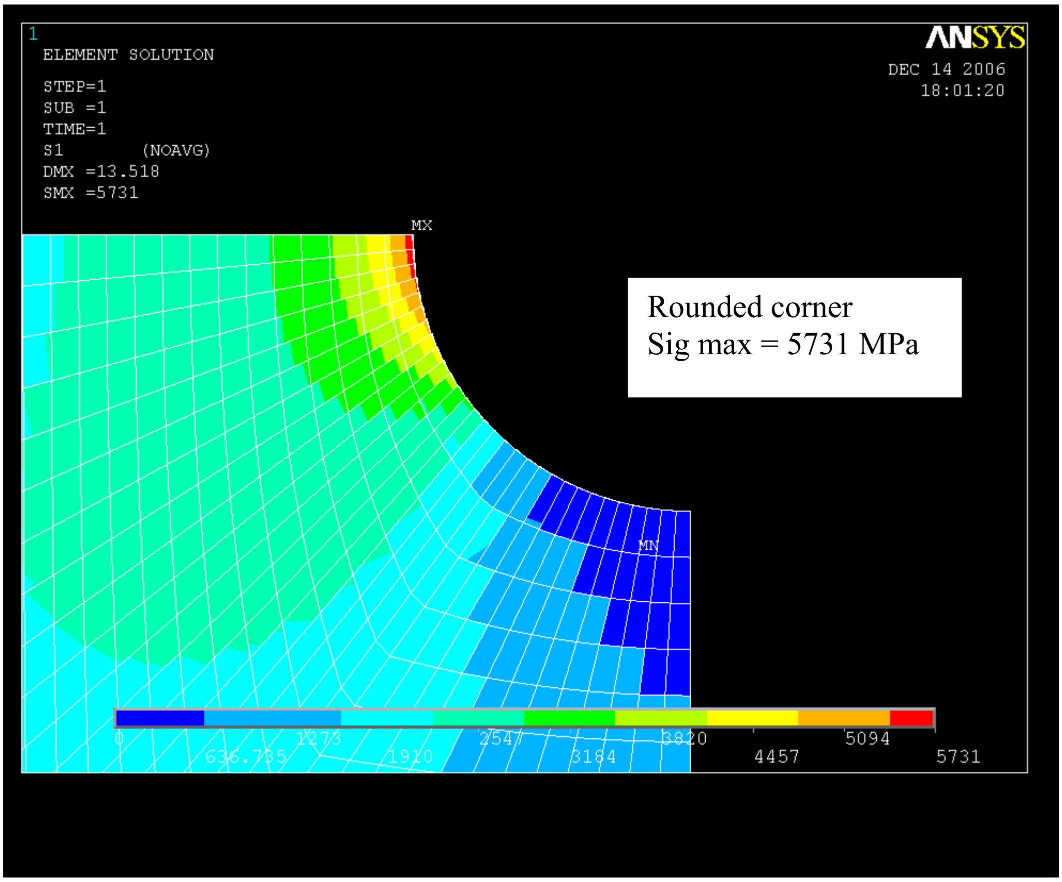
The mean stress is calculated as follow for a simple tensile test without any hole:

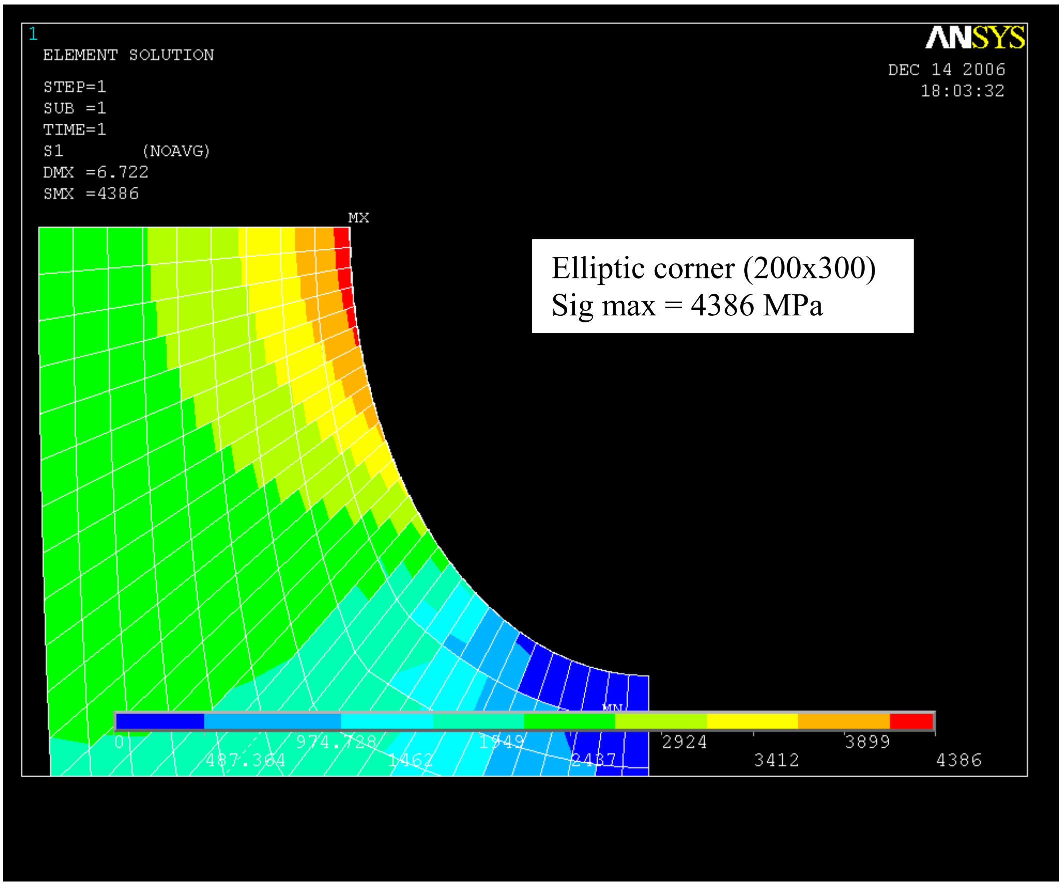
$$\sigma_{mean} = E\ \varepsilon$$
$$\varepsilon = 0.01$$
$$\sigma_{mean} = 2060 \quad MPa$$

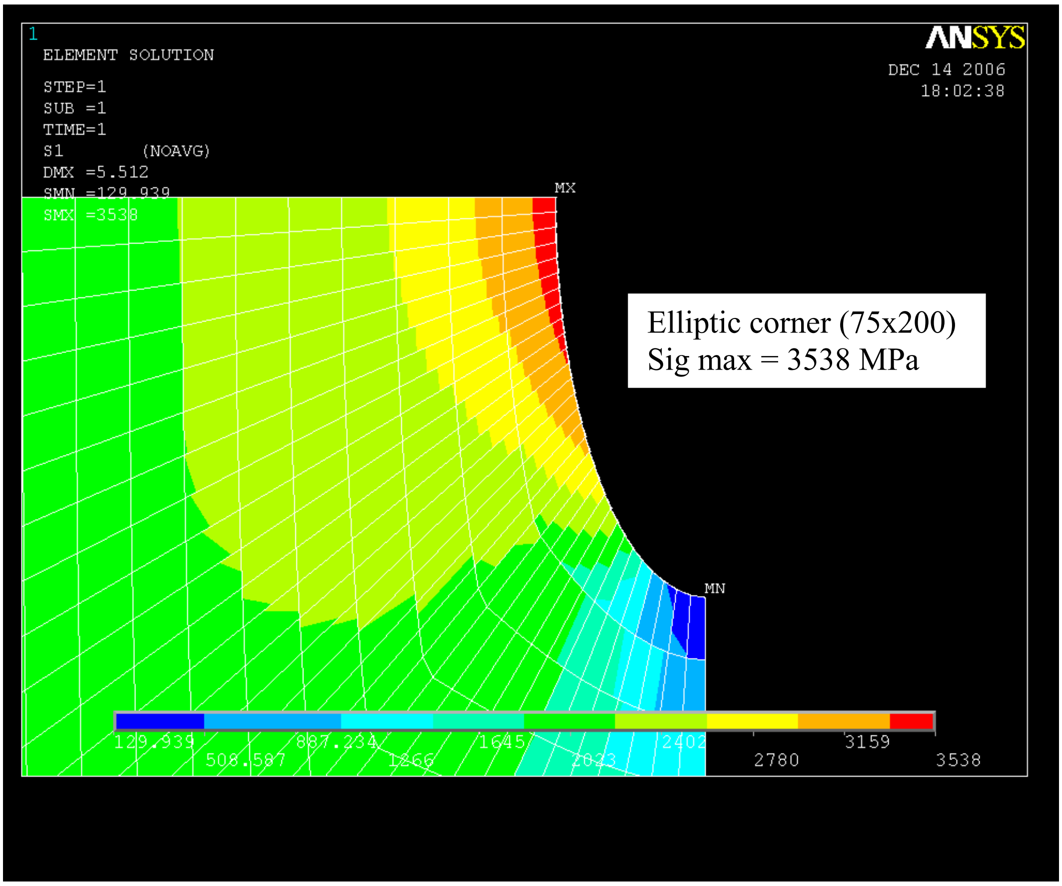
- Maximum stress

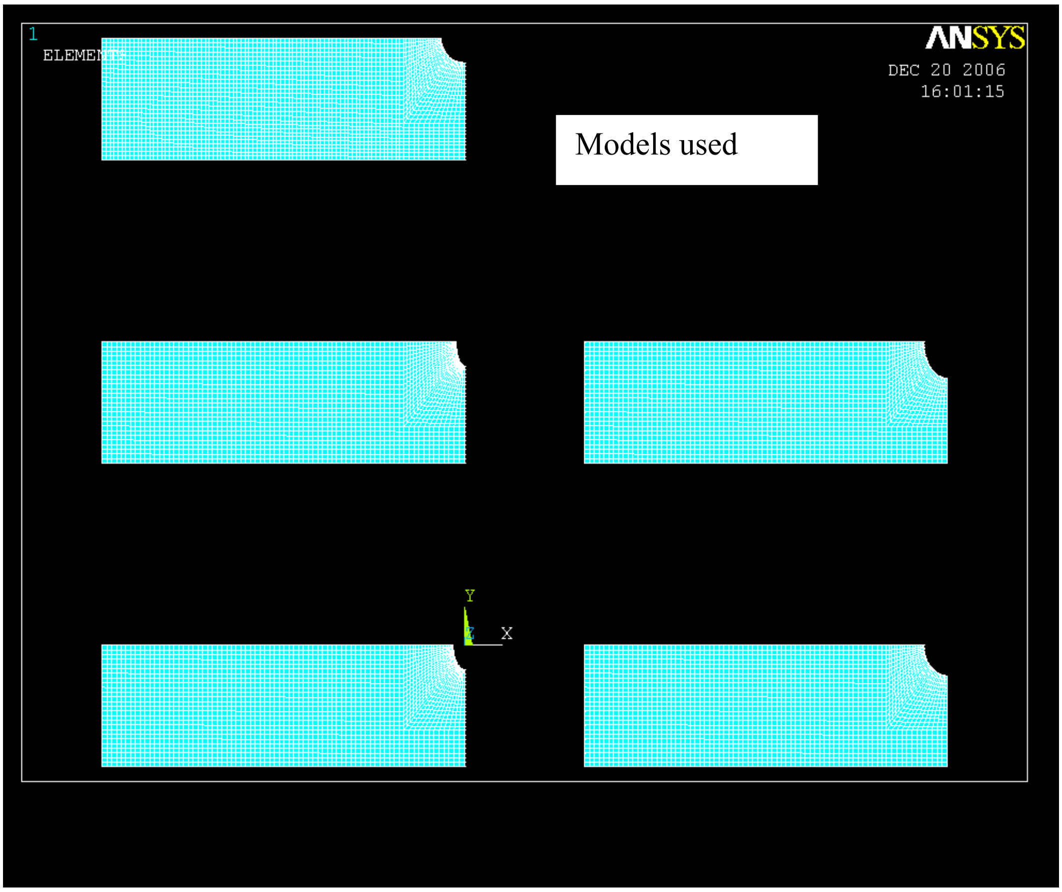
This is the greatest principal stress read in the model as shown on the following pictures.

ANSYS 9.0 tests






1
ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
S1 (NOAVG)
DMX =5.512
SMN =129.939
SMX =3538
ANSYS
DEC 14 2006
18:02:38
MX
MN
Elliptic corner (75x200)
Sig max = 3538 MPa
129.939
508.587
887.234
1266
1645
2023
2402
2780
3159
3538

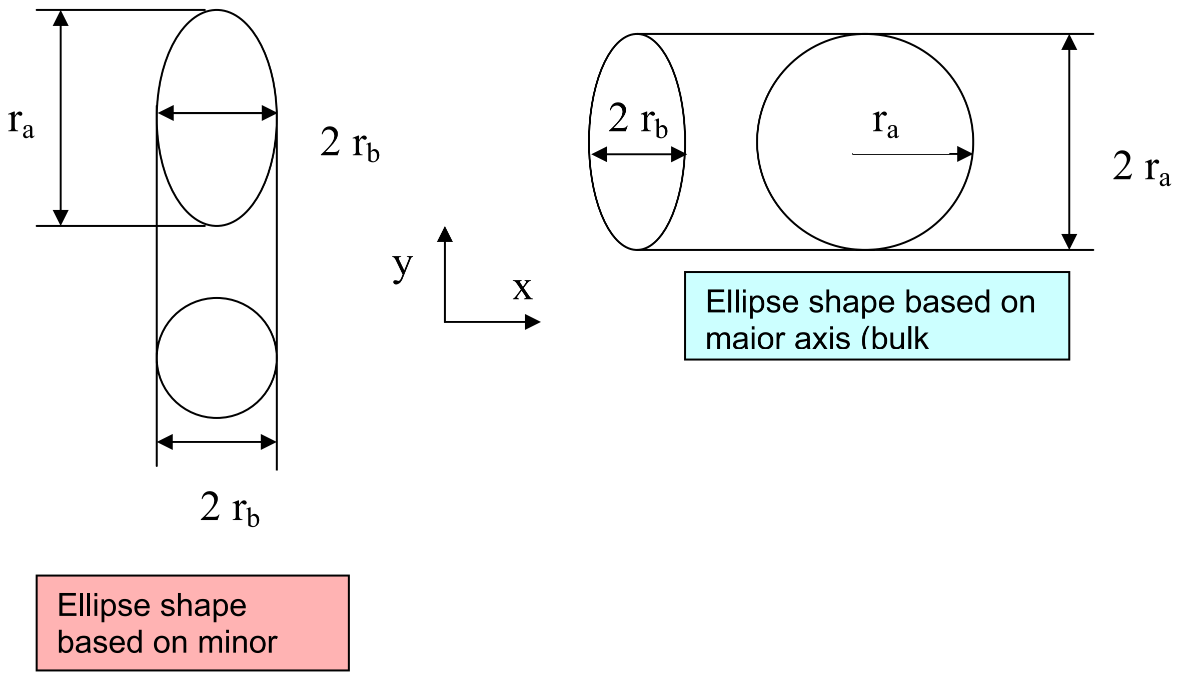

1
ELEMENTS
ANSYS
DEC 20 2006
16:01:15
Models used
Y
Z
X

Results

Comparison between Kt eval (f_c) and Kt real (ANSYS software) for the different ellipses

Shape	dimensions	Maximum stress	Kt real (Max stress/2060)	Correction factor f_c	Kt evaluated (2.78* f_c)	Kt eval /Kt real
Circular hole	200x200	5731	**2.78**	**1**		
Ellipse 1	50x200	3057	1.48	0.5	1.39	0.94
Ellipse 2	75x200	3538	1.72	0.58	1.62	0.94
Ellipse 3	100x200	4009	1.95	0.67	1.85	0.95
Ellipse 4	200x250	4928	2.39	0.87	2.42	1.01
Ellipse 5	200x300	4386	2.13	0.78	2.17	1.02
Ellipse 6	200x400	3702	1.8	0.67	1.85	1.03

We can see that r_b radius is a more conservative basis than r_a to evaluate the influence of an elliptic shape. The error is a bit less than for r_a and the Kt obtained is over evaluated (r_b basis) instead of being under evaluated (r_a).



KC#386

Stress Concentration around Hatch Corner of Bulk Carrier

1. Simplified Fillet Shoulder Model of Hatch Corner

When evaluating a stress concentration around hatch corner of bulk carrier subject to the longitudinal stress due to vertical hull girder bending moment, that is illustrated in Fig.1(a), the shaded area in cross deck is the area where the longitudinal stress is not worked. Therefore, in order to evaluate the stress concentration around hatch corner of bulk carrier, the simplified fillet shoulder model shown in Fig.1(b) can be used.

The height of fillet shoulder depend on the degree of disturbance of longitudinal stress flow occurred due to the structural discontinuity around hatch corner.

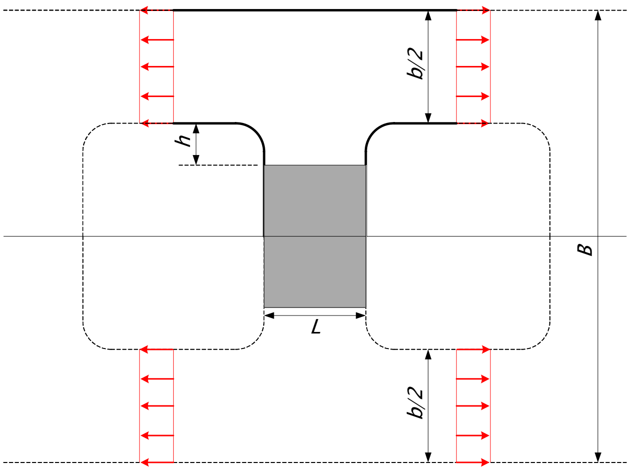


Fig. 1(a) Hatch Opening of Bulk Carrier

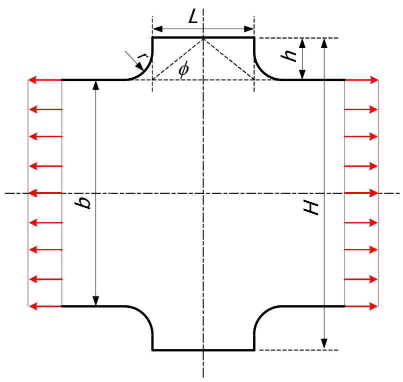


Fig. 1(b) Simplified Fillet Shoulder Model

2. Stress Concentration Factor

2.1 Experimental Formula

The stress concentration factor for the stepped flat tension bar with fillet shoulder was given by Heywood [Heywood, R. B., "Photo-elasticity for Designers", Pergamon, New York, 1969] as below.

$$\alpha = 1 + \left(\frac{b}{2.8H - 2b} \frac{H-b}{2r} \right)^{0.65} = 1 + \left(\frac{b}{5.6h + 0.8b} \frac{h}{r} \right)^{0.65} = 1 + \left(\frac{b}{2.8L \tan\phi + 0.8b} \frac{L\tan\phi}{2r} \right)^{0.65}$$

The above formula can be applied in evaluating the stress concentration factor to the nominal hull girder vertical bending stress which acts on the ship's side part of upper deck. The above formula gives the stress concentration factor for the hatch corner of circular arc shape. Although an elliptic arc shape is often used to decrease stress concentration in the actual design, there are no analytical nor experimental results regarding on the stress concentration for the fillet shoulder with elliptic arc shape.

Here, following simple correction factor for the elliptic arc shape is assumed. This correction factor gives the ratio of stress concentration for the tension of an infinite width thin element with an elliptic hole to that with a circular hole. In this equation, r_a denotes the radius in major axis and r_b denotes the radius in minor axis. This correction factor can be applied to the stress concentration factor for the fillet shoulder with circular arc shape of radius r_a.

$$f_c = \frac{1}{3} + \frac{2r_b}{3r_a}$$

2.2 Disturbance of stress flow

As shown in Fig. 1(a), the disturbance of longitudinal stress flow is occurred at the opening corner due to the structural discontinuity around hatch corner. This disturbance of stress flow causes stress concentration and the degree of stress concentration depends on the angle of disturbed stress flow ‘ ϕ ’ and the length of shoulder. According to the photoelasticity experimental results, it is said that the angle of disturbed stress flow was about 10 to 30 degree. According to the results of FE analysis of bulk carrier made by NK, the angles of disturbed stress flow around hatch corner were about 15 to 30 degree as shown in Table 1.

Table 1 Angle of disturbed stress flow to the longitudinal direction

Location	Angle to the longl. Direction.
Opening at mid part	16.5 ～ 28.9
Foremost opening	23.0

2.3 Shape of Hatch Opening of Bulk Carrier

The degree of stress concentration at hatch corner is also depending on the shape of hatch opening on the upper deck. Table 2 shows the results of the survey of existing bulk carriers.

According to the Table 2, the ratio of ‘H’ to ‘b’ is about 1.1 to 1.3. And the ratio of ‘ r_a ’ to ‘b’ is about 0.05 to 0.07.

Table 2 Shape of Hatch Opening of Typical Bulk Carriers

S. No.	Lpp	B	Length	Width	L	b	H(15)	H(20)	H(25)	H(30)	major r	minor r
BC1	179.80	31.00	20.80	17.60	8.00	13.40	15.54	16.31	17.13	18.02	0.90	0.45
BC2	185.00	32.26	20.47	18.60	8.90	13.66	16.04	16.90	17.81	18.80		
BC3	215.00	32.20	17.85	14.58	7.65	17.62	19.67	20.40	21.19	22.04	1.22	0.61
BC4	279.00	45.00	16.32	20.16	10.56	24.84	27.67	28.68	29.76	30.94		
BC5	279.00	45.00	14.72	21.00	11.04	24.00	26.96	28.02	29.15	30.37	1.36	0.78
BC6	279.20	45.00	15.47	20.00	10.01	25.00	27.68	28.64	29.67	30.78		
BC7	290.20	50.00	15.76	23.40	10.84	26.60	29.50	30.54	31.65	32.86		

2.4 Examples of Stress Concentration Factor

Figure 2(a) and 2(b) show the results of evaluated stress concentration factor for the hatch corner where a circular arc shape and an elliptic arc shape are applied respectively. In these figures, $x = r_a/b$ and $p = H/b$.

When an elliptic arc shape is applied to the hatch corner, the stress concentration becomes sufficiently small.

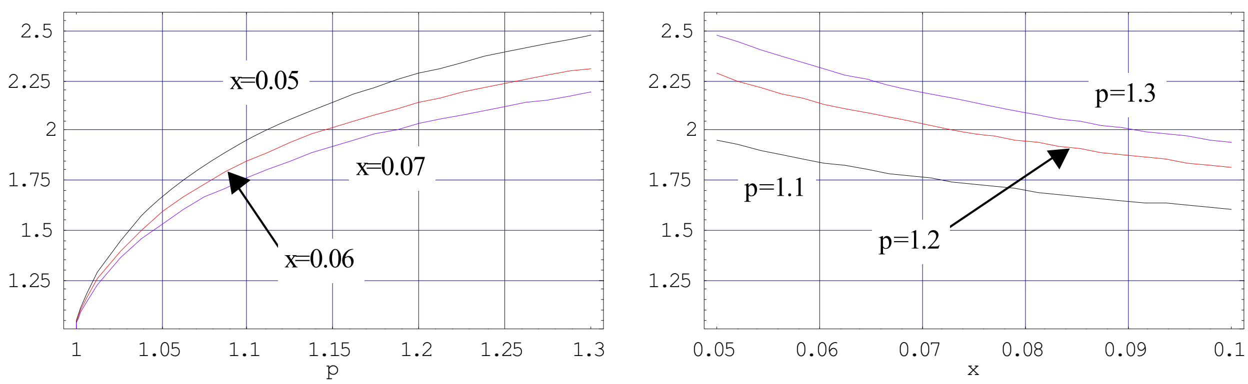


Fig. 2(a) Stress Concentration Factor when the Corner is Circular Arc Shape

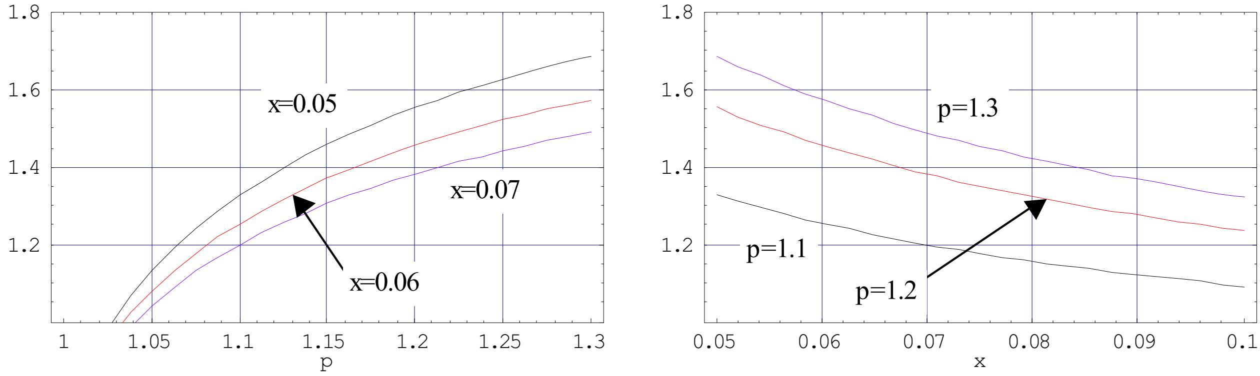


Fig. 2(b) Stress Concentration Factor when the Corner is Elliptic Arc Shape

3. Proposed Formula of Stress Concentration Factor

The stress concentration factor for the hatch corner is proposed as below.

$$\alpha = \max\left[1.0,\quad \frac{r_a + 2r_b}{3r_a}\cdot\left\{1+\left(\frac{b}{1.23L+0.8b}\frac{0.22L}{r_a}\right)^{0.65}\right\}\right]$$

where r_a ; radius in major axis

r_b ; radius in minor axis (if the shape of corner is a circular arc, r_b is to be equal to r_a)

L ; length of cross deck

b ; distance from the edge of hatch opening to the ship's side

KC#603

1. For bottom structure:
   - The relative displacement is defined as the distance measured from the intersection of adjacent floor to bottom / inner bottom to the base line;
   - The base line is defined as the line between intersection points of the floors to bottom / inner bottom in way of fore and aft of lower stools; (blue lines in Fig. 1)
   - The displacement with a direction from the flange of considered stiffener to the attached plate is defined as positive.

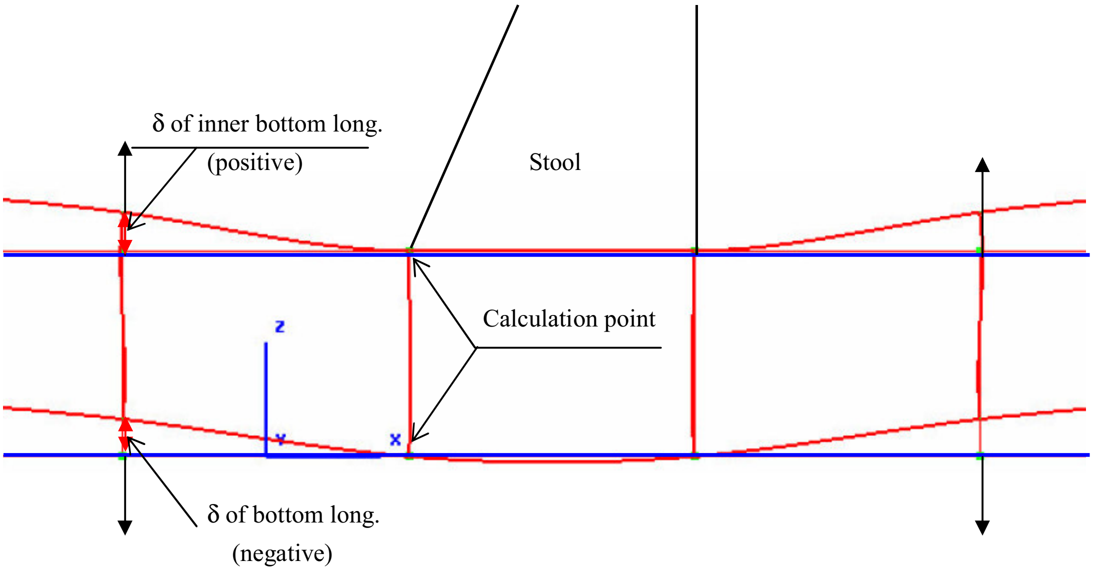


Figure1

2. For side shell structure:
   - The relative displacement is defined as the distance measured from the intersection of adjacent ring to attached plate to the base line;
   - The base line is defined as the line perpendicular to the transverse bulkhead; (blue lines in Fig. 2)
   - The displacement with a direction from the flange of considered stiffener to the attached plate is defined as positive.

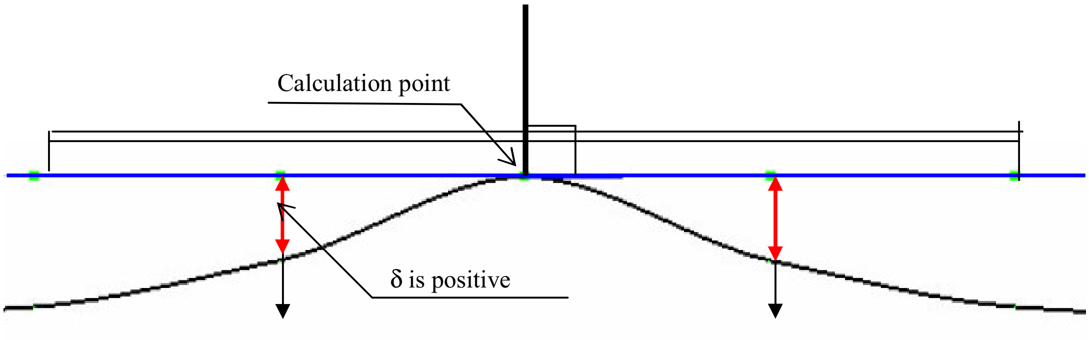


Figure 2

3.3b　被害度の算定は設計寿命である 25 年間の波浪変動の繰返し数に対して行う。ただし，貨物の荷役，検査保守などの理由により停船すること及び，荷役地周辺の静穏海域の航海を考慮し，全寿命のうち 85%が有効であるとした。

3.3c　標準的なばら積貨物船の代表積付状態の頻度は船会社へのアンケート，コメントに基づき設定した。

4.　疲労強度基準

4.1　累積疲労被害度

4.1a　評価疲労被害度の基準値は，全ての場合について 1.0 とするが，用いる線図に安全余裕が含まれているので，評価結果に暗黙のうちにこの安全余裕が含まれる。

3 節　主要部材の応力評価

1.　一般

1.1　適用

1.1a　主要部材の疲労強度評価を行うための，ホットスポット応力の評価手順について記述する。

2.　ホットスポット応力範囲

2.1　直接法による応力範囲

2.1a　主要部材のホットスポット部の応力を評価する場合には，詳細メッシュを用いたホールドモデルに設計荷重を負荷して評価する必要がある。直接法ではハルガーダモーメントと設計波による荷重とを同時にモデルに負荷させて応力を評価する。応力範囲は波の山谷の 2 状態における応力値の差から求める。

2.1b　詳細メッシュを用いたホールドモデルの応力解析は，規則 7 章 4 節を参照

2.2　重ね合わせ法による応力範囲

2.2a　重ね合わせ法では，設計波による荷重をモデルに負荷させて評価した応力に，別途求めるハルガーダモーメントによる応力を重ね合わせることにより合応力を評価する。応力範囲は波の山谷の 2 状態における応力値の差から求める。

2.2b　ハルガーダモーメントによる応力は，船体梁に曲げモーメントを考慮して求める。ホットスポット応力を求める際には，梁理論で求められた公称応力に応力集中係数を考慮するが，主要部材についてハルガーダモーメントによる応力に対する応力集中率が 1.0 に近い値を示すので，本規則ではハルガーダモーメントによる応力に対する応力集中率＝1.0 を考慮する。

2.2c　詳細メッシュを用いたホールドモデルの応力解析は，規則 7 章 4 節を参照

3.　ホットスポット平均応力

3.1　直接法による応力範囲

3.1a　主要部材のホットスポット部の平均応力を評価する場合には，詳細メッシュを用いたホールドモデルに波の山谷の 2 状態の設計荷重およびハルガーダモーメントを負荷して評価される応力値の平均から求める。

3.2　重ね合わせ法による平均応力

3.2a　重ね合わせ法では，波の山谷の 2 状態の設計波による荷重をモデルに負荷させて評価した応力の平均値に，別途求める静水中縦曲げモーメントによる応力を加えることにより求める。

3.2b　静水中縦曲げモーメントは，規則 4 章 3 節を参照。

3.2c　初期設計の段階で静水中縦曲げモーメントが定められない場合に対して，許容静水中縦曲げモーメントを用いた各積付状態における評価式を示した。

4 節　縦通材の応力評価

1.　一般

1.1　適用

1.1a　縦通部材端部結合部の疲労強度評価を行うための，ホットスポット応力の評価手順について記述する。

2.　ホットスポット応力範囲

2.1　直接法による応力範囲

2.1a　8 章 3 節 2.1 を参照

2.2　重ね合わせ法による応力範囲

2.2a　8 章 3 節 2.2 を参照

2.3　簡易手法による応力範囲

2.3a　梁理論により公称応力を評価し，応力集中係数を乗じることによりホットスポット応力を求める手法である。応力の評価は，荷重成分毎に梁理論により応力を求めて重ね合わせる。この際，面外圧力の負荷される方向により応力の符号が異なることに注意を要する。

2.3b　各成分の荷重は規則 4 章の該当節を参照

2.3c　縦通材が横置隔壁或いは横桁を貫通する位置において防撓材，肘板等で結合される場合，結合部分の構造的な不連続により応力が増加する。簡易手法では公称応力にこの影響を考慮した応力集中係数を乗じて評価を行う。縦通肋骨のこのような箇所の継ぎ手詳細構造については，これまで多くの設計建造実績があるので，設計の便を考え，これらの代表的な継ぎ手詳細に対する応力集中係数を示した。これら係数の値は，詳細モデルによる FE 解析の結果を取りまとめたものである。表中に示す評価点のうち，応力的に厳しくないことが自明な点については，貫通部をカラープレートで塞ぐか否かの違いによる係数の違いは無視できるので省略している。

2.3d　波浪，液体貨物，粒状乾貨物による応力を評価する場合，継手詳細形状に起因する応力集中係数とは別に非対称断面防撓材の横倒れに伴う応力上昇の影響を考慮し，弾性梁理論により求められた応力集中係数を考慮する。

2.3e　有効スパン及び心距の定義については，規則 3 章 6 節を参照

2.3f　波浪或いは液体貨物等の変動圧力による応力範囲を評価する場合，喫水或いは自由表面近傍においては，評価対象部材の位置と波面或いは液面変動の位置関係から圧力を受けない場合が生じる（負圧が生じない）。この影響は部材位置と波或いは液の変動面の位置関係を，また，変動面の高さは波浪或いは加速度の大きさとその発現頻度を考慮して評価する必要がある。本規則ではこれらを考慮し，波或いは液の変動に対して非線形な応力範囲を，確率的に等価な線形応力範囲で取り扱えるよう

KC#742

KC Question ID 742, 28 April 2008 (from LR)

The members and locations subjected to fatigue analysis are described in Table 1 of **Ch 8,** Section 1 of CSR bulk carrier Rule (see below table). Could you please clarify following queries:-

Members	Details
Inner bottom plating	Connection with sloping and/or vertical plate of lower stool
	Connection with sloping plate of hopper tank
Inner side plating	Connection with sloping plate of hopper tank
Transverse bulkhead	Connection with sloping plate of lower stool
	Connection with sloping plate of upper stool
Hold frames of single side bulk carriers	Connection to the upper and lower wing tank
Ordinary stiffeners in double side space	Connection of longitudinal stiffeners with web frames and transverse bulkhead
	Connection of transverse stiffeners with stringer or similar
Ordinary stiffeners in upper and lower wing tank	Connection of longitudinal stiffeners with web frames and transverse bulkhead
Ordinary stiffeners in double bottom	Connection of longitudinal stiffeners with floors in way of transverse bulkhead
Hatch corners	Free edge of hatch corners

(1) The fatigue performance of members and loactions **in red font** in above table need to be evaluated using very fine mesh FE model, the other parts can be evaluated using simplified method.

For very fine mesh analysis, which cargo hold should be done? Heavy ballast hold, Heavy cargo hold or Light cargo hold?

(2) The transverse BHD connection with **sloping** lower stool and upper stool should be checked, but how about transverse BHD connection with **vertical** lower stool and upper stool? Should it be checked as well or just ignored it?

(3) Which locations should be checked, for example:-

(3-1)Inner bottom plating/connection with sloping and/or vertical plate of lower stool **Centreline or full breath?**

(3-2)Inner bottom plating/ Connection with sloping plate of hopper tank **Mid-hold or full length of hold?**

(3-3)Inner side plating/ Connection with sloping plate of hopper tank **Mid-hold or full length of hold?**

(3-4)Transverse bulkhead/ Connection with sloping plate of lower stool **Centreline or full breath?**

(3-5)Transverse bulkhead/ Connection with sloping plate of upper stool **Centreline or full breath?**

(3-6) Hold frames of single side bulk carriers/ Connection to the upper and lower wing tank **Mid-hold or full length of hold?**

END

KC#875

CSR KC ID 875, Question

Loading Conditions		BC-A	BC-B、BC-C
L<200m	Homogeneous	0.6	0.7
	Alternate	0.1	---
	Normal ballast	0.3	0.3
L≧200m	Homogeneous	0.25	0.5
	Alternate	0.25	---
	Normal ballast	0.5	0.5

KC#999