



SAFEHULL SYSTEM FOR BULK CARRIERS

GUIDE ON IMPROVEMENT FOR STRUCTURAL CONNECTIONS AND SAMPLE STRUCTURAL DETAILS —SERVICE EXPERIENCE AND MODIFICATIONS— FOR BULK CARRIERS

OCTOBER 1995



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**Guide on
Improvement for Structural Connections and
Sample Structural Details
— Service Experience and Modifications —
for Bulk Carriers**

October 1995

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the State of New York 1862**

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1.0 GENERAL

This Guide identifies the influential parameters and provides guidelines on improvement of structural connections. It also provides for reference illustrations of local structural failures experienced in some existing bulk carriers and the corrective measures as compiled by the IACS and from the American Bureau of Shipping's data files.

For structural details similar to those in tankers, reference illustrations are to be found in the "Guide on Improvement for Structural Connections and Sample Structural Details - Service Experience and Modifications - for Tankers".

2.0 INFLUENTIAL PARAMETERS

For design of structural details, due consideration is to be given to the following influential parameters.

2.1 Loading Patterns and Nominal Stresses

The load distribution among the connected structural members and the corresponding nominal stresses at the location considered should be examined for the combined load cases specified in 5/3A3.5.2. It is important to consider the combined effects of all the simultaneously imposed load components, rather than only one selected dominating load component. The stress distribution may be obtained from a 3D structural analysis as specified in 5/3A5.3 or by other equivalent means.

2.2 Stress Concentration

Due to load transmission and diffusion at a structural joint, it is inevitable that some form of stress concentration is going to occur in the loaded structure. Therefore, particular attention should be paid to structural notches, abrupt changes in structural properties and excessive distortions and deformations; such as locations at bracket toes, cut-outs, terminations of heavily loaded members, connection of flexible elements with much stiffer members, ends of unbalanced structural members, just to name a few. For ship structures

designed with relatively low working stresses and high safety margins, the detrimental effects of such stress concentrations may not readily be apparent. On the other hand, for structures designed with high working stresses and low safety margins, damaging effects of such stress concentrations could appear sooner than the anticipated period of time.

Appropriate stress concentration factors (SCF's) obtained from either experimental data or structural analyses are required to evaluate the design of structural details.

2.3 Weld Effects and Fatigue Strength

Another important factor to be considered is the effects of welding on the properties of material (heating effects) and on structural continuity (profile of the weld deposit and undercuts). This factor which highly depends on the welding methods, processes and workmanship is vital for assessing fatigue strength of the joint. To date, the welding effects on fatigue strength are primarily determined by experimental data presented in the form of S-N curves and characteristics of the test specimens, as shown in Appendix 5/3AA of the Rules.

3.0 CONSIDERATIONS FOR DESIGN OF STRUCTURAL DETAILS

In light of the discussions given in 5/3A5.4, it is apparent that the necessary criterion for the design of structural details is simply to offer a well balanced joint which is "compatible" with the anticipated working stresses. To this end, the solution is to be tailored to a specific location of a specific design. In addition, there is no unique solution to the problem. Many alternatives may exist. The designers/builder would have to exercise their judgment based on their fabrication facilities, techniques and experience. The information offered below is provided for reference.

3.1 Hold Frames and End Brackets

When selecting and sizing brackets connecting hold frames, due consideration should be given to the load transmission and relative stiffness of the members to be connected. A

pattern of smooth load transmission is essential. The connecting bracket is to be of sufficient size to withstand the highly concentrated loads and to relocate the critical spots (bracket toes) to lower stressed regions. Sample illustrations are shown in Figures 1, 1a and 1b for damages experienced in existing bulk carriers with some recorded repairs.

3.2 Connection of Transverse Bulkhead Structures

To prevent local fractures and to minimize the magnifying effects of structural notches, and misalignment/discontinuities consideration should be given to local reinforcements at the critical areas. Sample illustrations are shown in Figures 2a thru 2f for local damages and some recorded repairs.

3.3 Connection of Double Bottom Structures

Sample damaged structural details and connections are illustrated in Figures 3a thru 3h for double bottom structures. Attention should be paid to the weld connections of the slope longitudinal bulkhead and the inner bottom plating.

3.4 Connections of Lower Wing Tank Structures

Sample damages experienced in the existing bulk carriers are shown in Figures 4a and 4b.

3.5 Structures and Connections Within the Upper Wing Tanks

Sample fractures and buckling of the transverse webs and brackets are shown in Figures 5a thru 5d.

3.6 Deck Structures

Illustrations are given for cracks at hatch corners, buckling of the cross deck structures and hatch coaming in Figures 6a thru 6d.

3.7 Forepeak Structures

Some structural damages are shown in Figures 7a and 7b for the supporting structures in the forepeak region.

3.8 Transition Region in the Foremost Cargo Hold

Sample structural damages and repairs are shown in Figures 8a thru 8d for connections of the panting stringers and hold frames.

Side Frame Structure

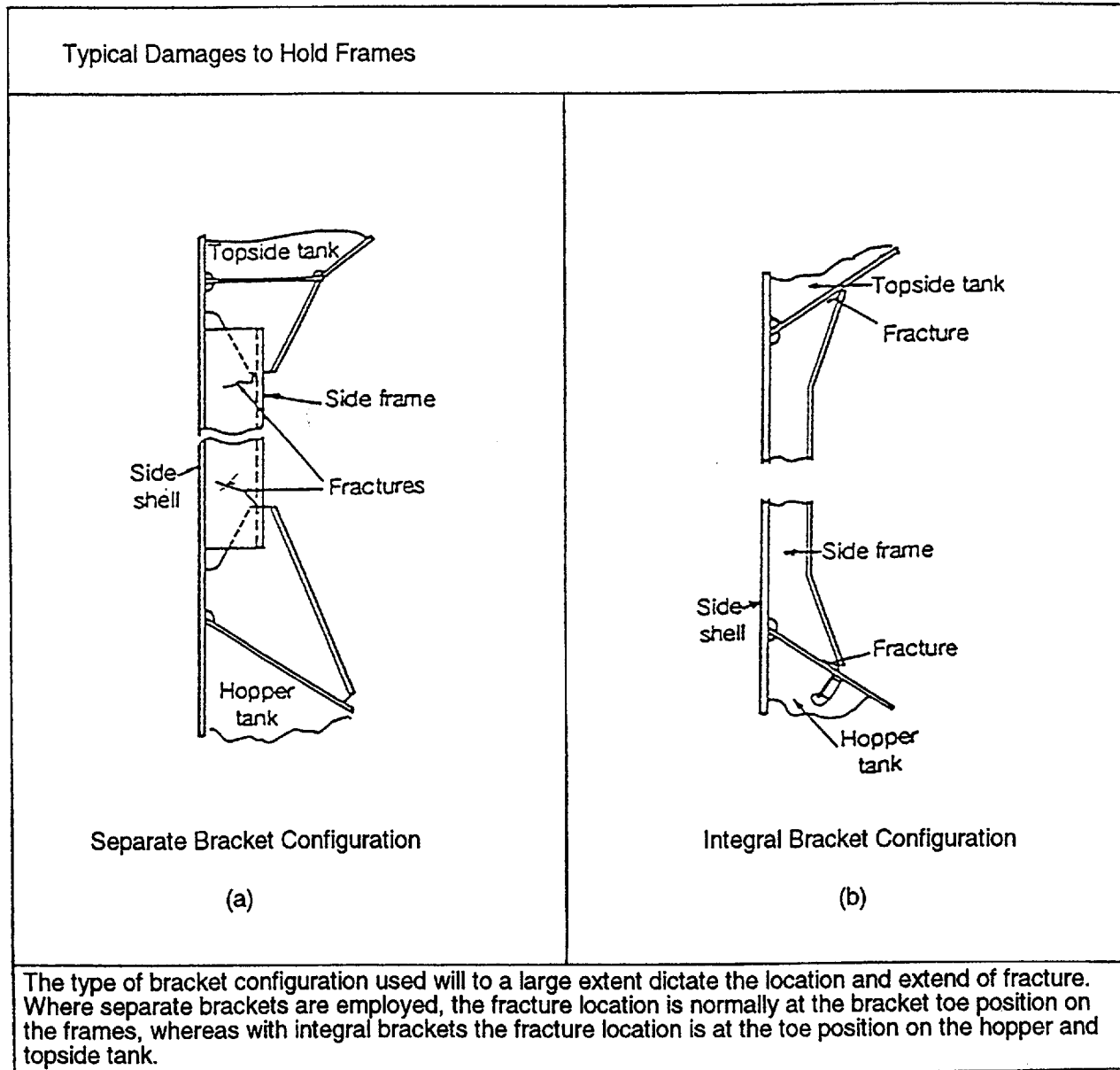


Figure 1

Side Frame Structure

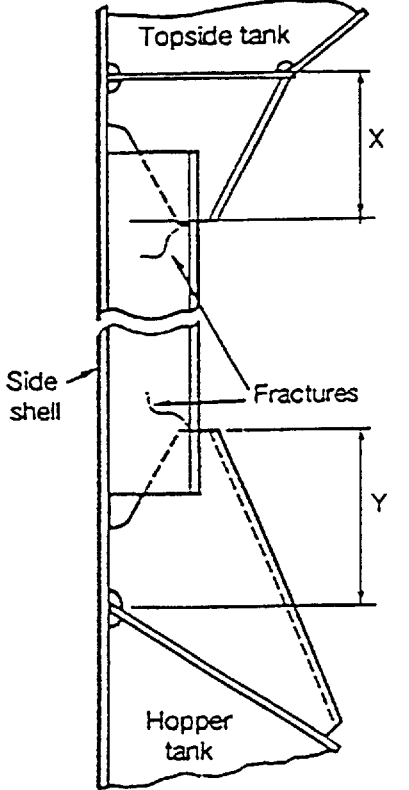
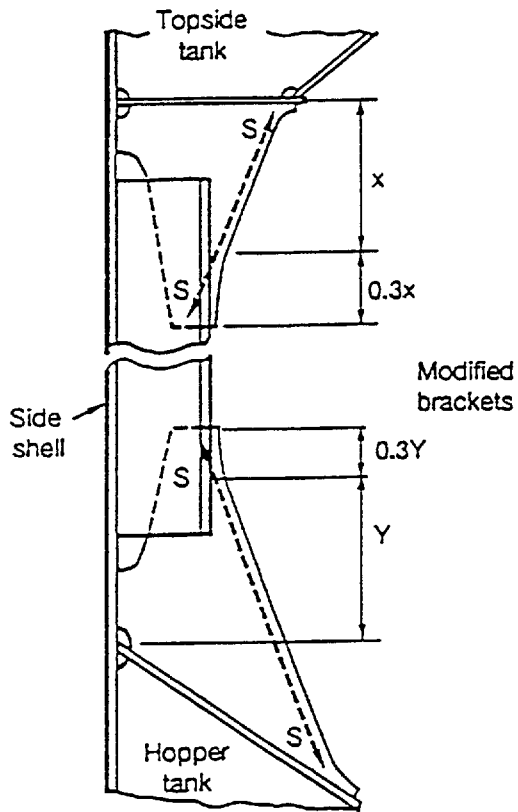
Detail of damage	Fractures at bracket's toe position on the frame
Sketch of damage  Topside tank Side shell Fractures Hopper tank Separate Bracket Configuration	Sketch of repair  Topside tank Side shell Modified brackets Hopper tank S = Snaped end

Figure 1a1

Side Frame Structure

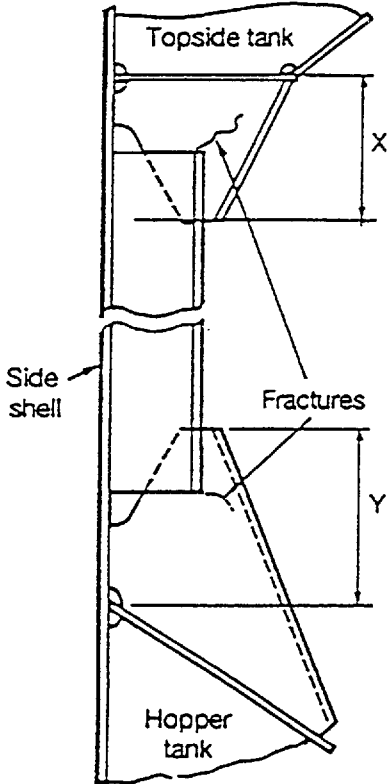
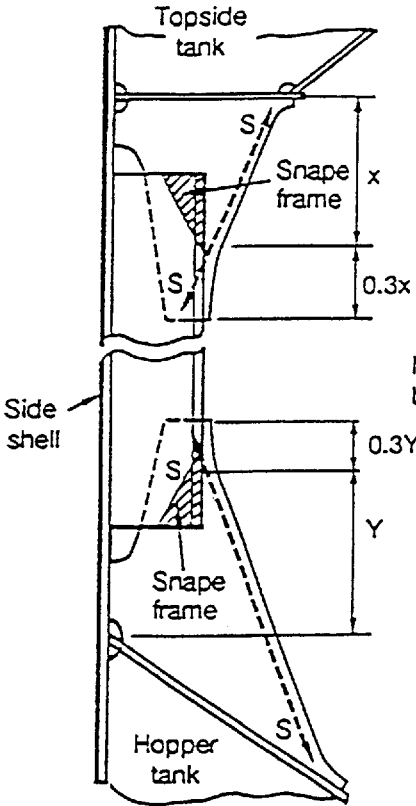
Detail of damage	Fractures on brackets at termination of frame
Sketch of damage  Separate Bracket Configuration	Sketch of repair  S = Snaped end

Figure 1a2

Side Frame Structure

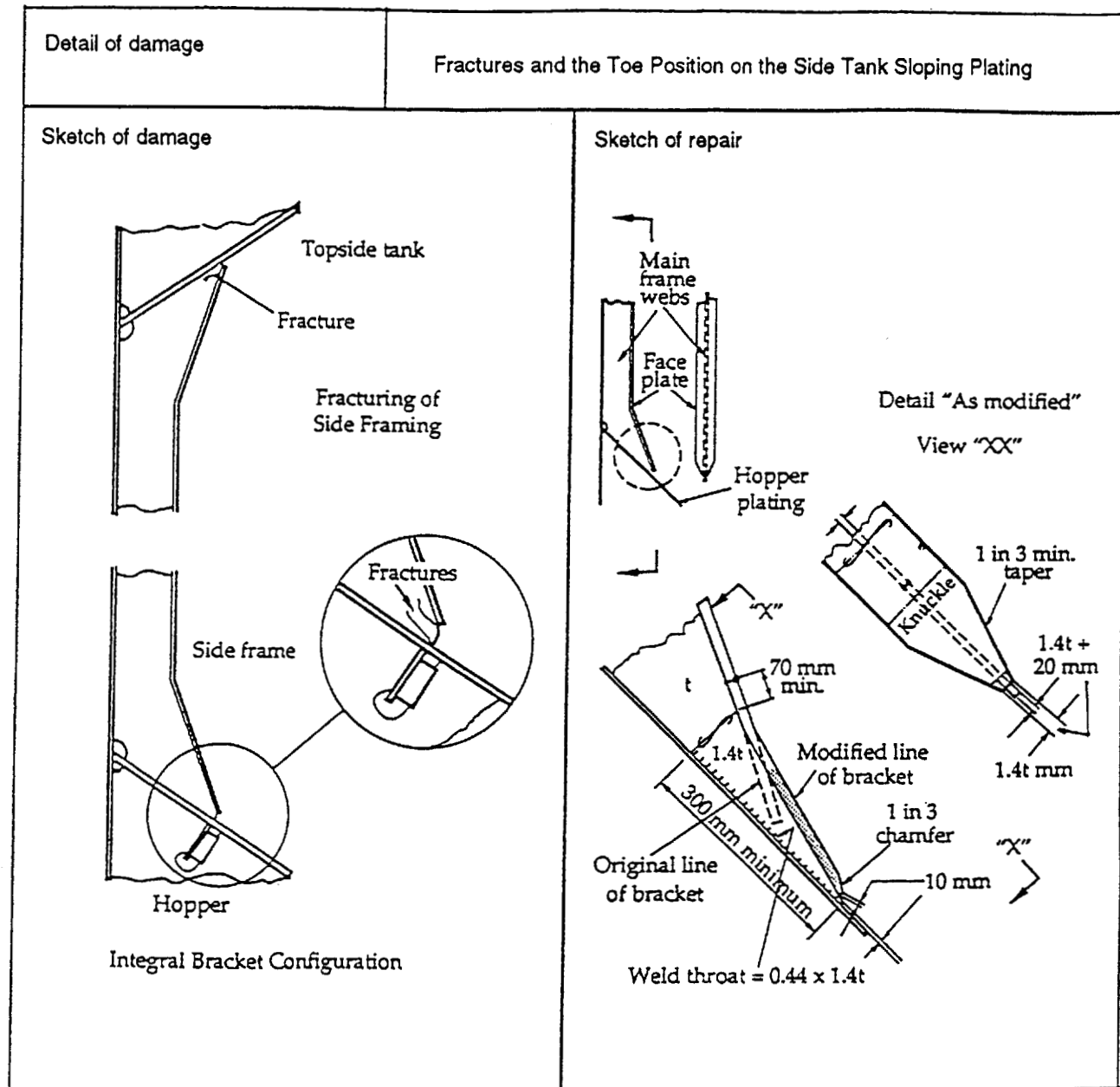
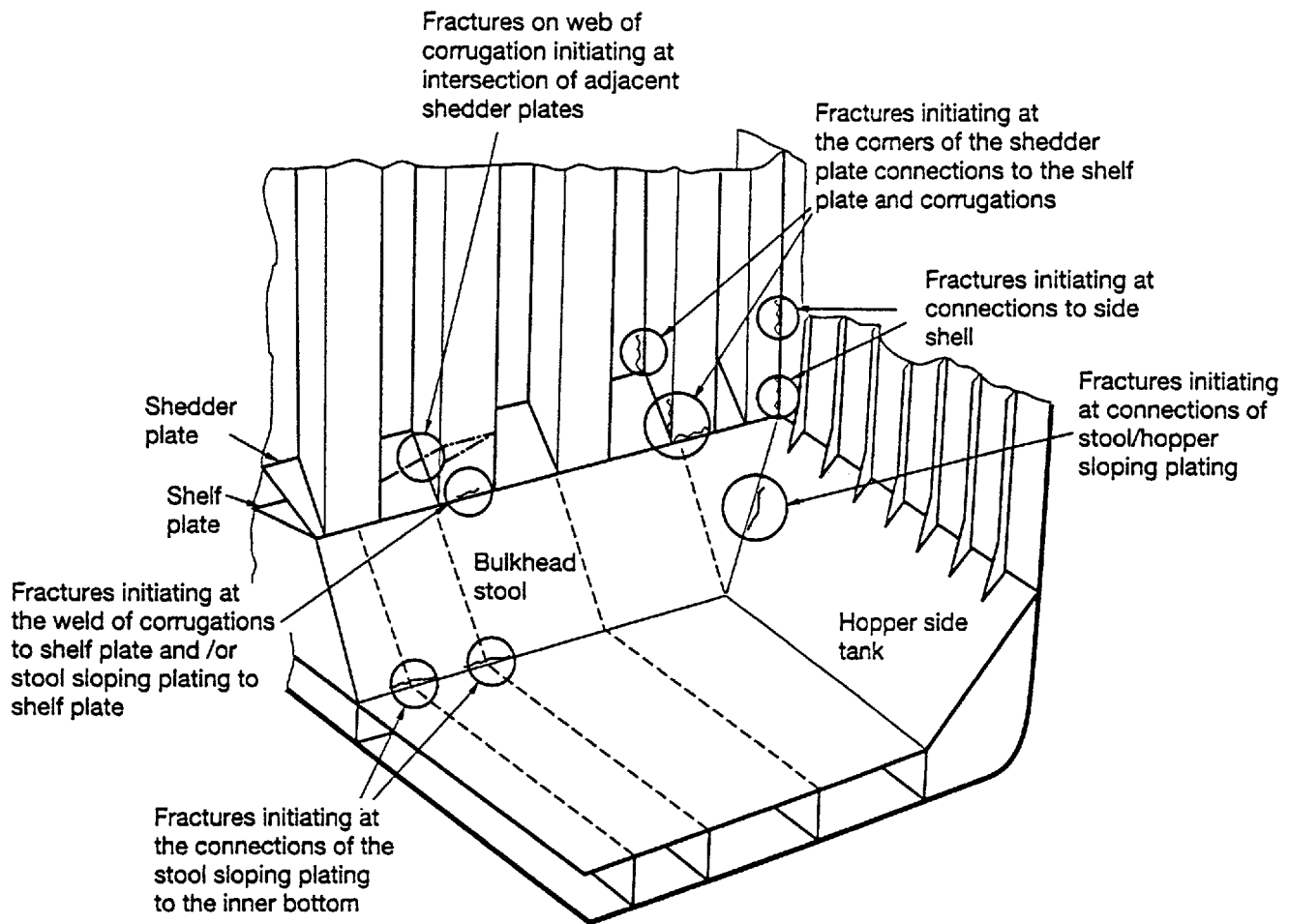


Figure 1b



(Similar damages may occur at the upper connections of the bulkhead to the deck structure)

Figure 2 Typical Fracturing at the Connection of Transverse Bulkhead Structure

Transverse Bulkhead Structure

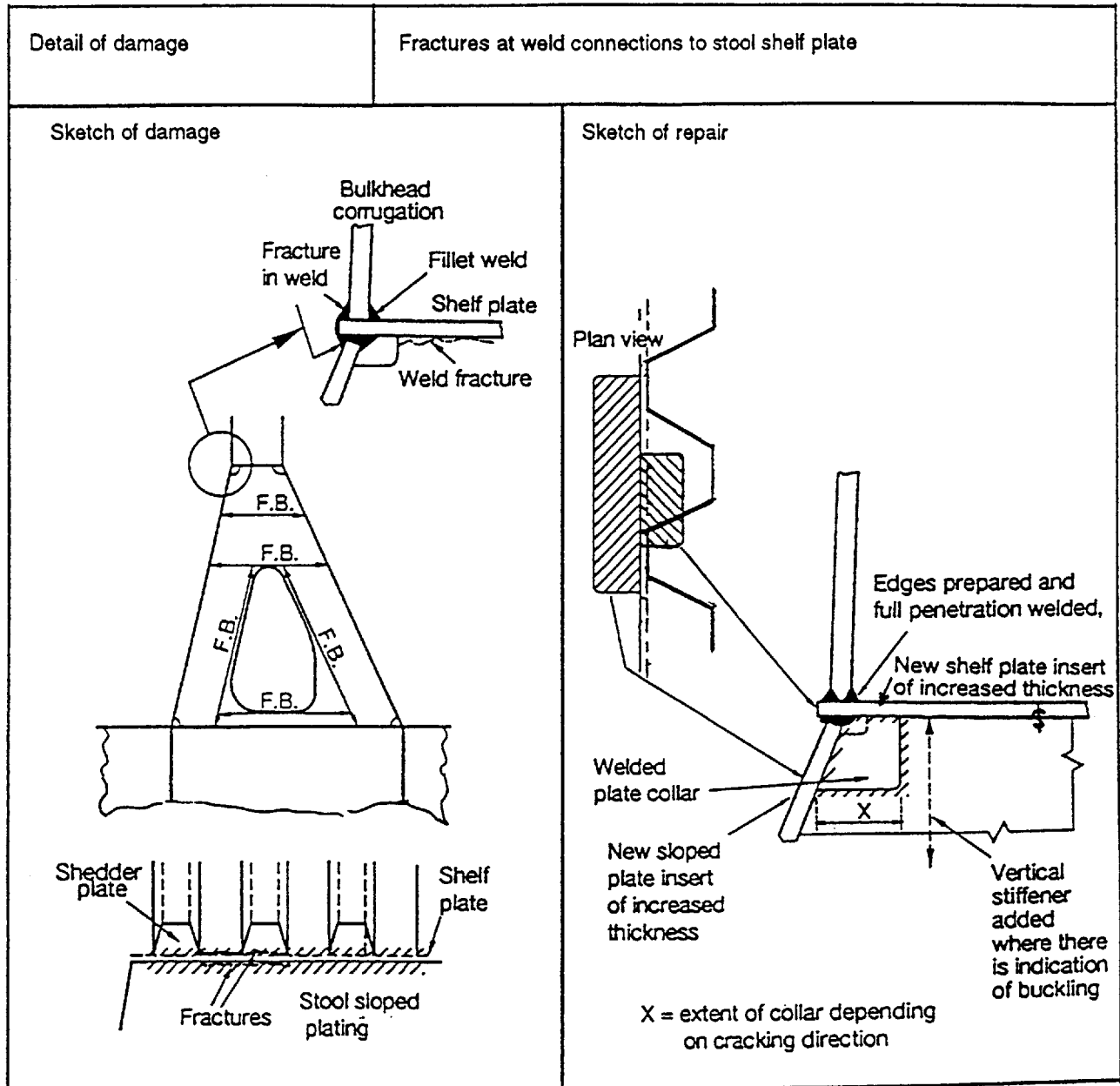


Figure 2a

Transverse Bulkhead Structure

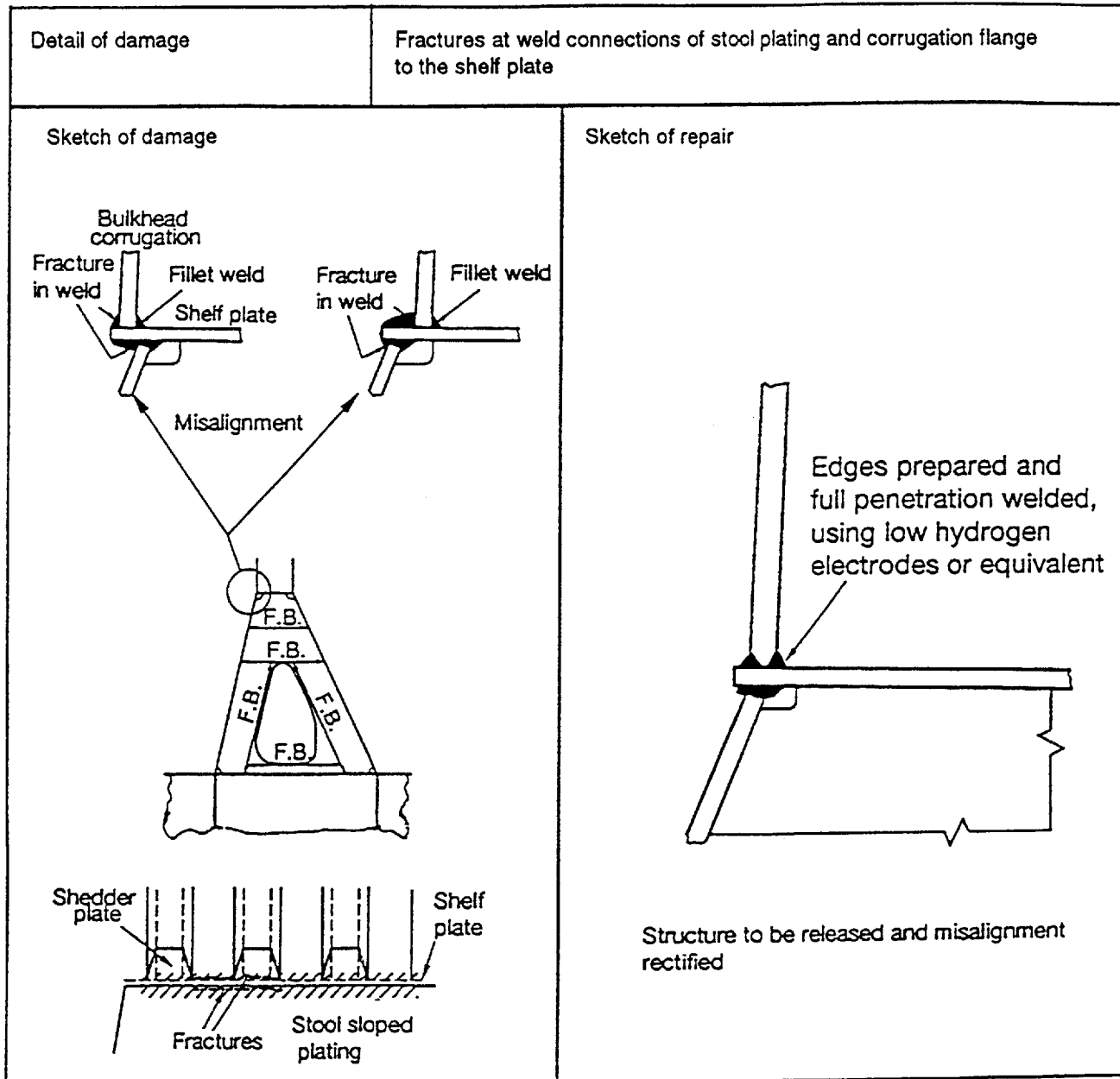


Figure 2b