Maximizing the useful life of rubber marine fenders

Ed Kiedaisch, Hi-Tech Marine Solutions LLC, Iowa, USA

The problem

Over the last fifteen years, the production of rubber marine fenders has moved from the manufacturers that developed them to lower-cost producers, with no heritage knowledge of the products they currently make. This has created a disjoint between the manufacturers and the people that design and sell the end products. There was precious little transfer of any of the 'black art' of fender element molding when the components were outsourced. Complicating matters, there are no true standards governing the 'nuts and bolts' of fender design. There is little to assist in the design of cost-effective fenders. Furthermore, there is little understanding of neither what actually causes fenders to fail, nor how buyers can optimize their fender lifetimes. This article seeks to change that.

Standards are of little practical help

The bad news for those looking to invest in new fenders is that the most critical issues for successful rubber marine fenders are not covered in any standard. Current standards and guidelines deal primarily with broad theories and virtually not at all with the simple details that make virtually all the difference between troublesome and robust designs.

The only extant standards deal with these general theories, the proprietary design of specific rubber fender elements (not the entire fender), and/or the assessment of the energy capacity of fender elements. The most widely used guideline for the design of fender systems is *Guidelines for the Design of Fenders* (sic) *Systems: 2002*, published by the International Navigation Association (PIANC). It gives guidelines for determining energy requirements, but no details of how to design a fender system. Its six-page Appendix A, 'Procedure to Determine and Report the Performance of Marine Fenders' is the only section of this seventy page document familiar to most fender specifiers.

However, not only is *Guidelines*…not a standard, but due to errors in the final editing process two critical sections were reversed. The result is that for the majority of testers a critical part of the procedure description is likely unintelligible. Thus, its actual usefulness is limited.

This is not as much of a problem as it otherwise would be, because the same year *Gudelines*… was published, ASTM International, the largest standards-writing organization in the world, issued Standard F 2192, 'Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Fenders'. An important revision was issued in 2005. This is the document that the performance testing part of Appendix A was intended to be, and it is the only standard for determining the performance of marine fenders.

ISO 9000 certification is not necessarily any assurance. Achieving ISO 9000 status requires that a manufacturer produce a consistently-repeatable product, and document it, but does not require that it make a product that is fit for service. On balance, it is better than nothing but not a magic bullet.

My own experience has led me to believe strongly that all the worry about measuring fender energy and reaction is a tempest in a teapot. Investigations of many fender problems, multiple types and manufacturers show that inadequate fender performance (energy and reaction) is almost never the primary cause of fender problems.

Also, seldom is fender compression deflection a cause of fender failure. Often specifications stipulate that fender deflection shall not exceed a certain percent of undeflected height (for durability concerns). Actually, fenders designed to have a greater rated deflection operate at a lower strain and stress level than ones designed to deflect less.

Specifying rubber

The ultimate useful life potential of any rubber product is controlled by its chemistry. Aging and ozone resistance of the rubber, from which fenders elements are molded, are two of the most important criteria that determine useful life potential. Most fender specifications don't specify rubber ozone resistance at all, and many specify an acceptable aging resistance that is considerably lower than it could be for maybe one per cent higher cost.

Good design can significantly increase the percentage of potential useful life that fenders actually achieve.

Furthermore, more than 95 per cent of fender rubber specifications are totally unenforceable, because they omit critical data. These omissions are so severe that they don't actually tie down some properties at all! Ironically, the more words used to specify rubber the more likely the specification is incomplete. A correct, detailed and binding specification can be written in three lines or less.

The simple errors that kill fenders prematurely

Other than 'premature' failure due to ozone attack or aging, most fender failures fall into two main groups, listed below in approximate order of frequency:

1. 'Hooking' of fender panels:

This can be subdivided into two types of failure:

a. Vertical movement

i. Simultaneous with inadequate tending of mooring lines. This can be caused by either large water level variations or, more commonly, by large draft changes (usually in dry or liquid bulk berths). Basically, when a vessel is moored tightly against a plastic-faced panel, with the vessel deck either below or only slightly above the elevation of the mooring bollard, the vessel subsequently moves downward without the mooring lines being adjusted adequately. This results in dragging the vessel hard against the fender panel, eventually locking the panel to the hull. Beyond this point, further downward movement of the vessel results in breakage of chain anchors, chains or brackets and finally the rubber element. (The rubber elements are almost always the last things to break. They actually protect the chains rather than the other way around!)

ii. Mooring lines passing under a fender position (under the water's surface, where they cannot be observed), when first attaching to a cleat or bollard, cause the lines to rise up under the fender when the line is winched in, after the vessel has been berthed against the fender in question and nobody is around to observe. The resultant, severe upward stretching of the fender can result in breakage of chain anchors, chains or brackets and finally the rubber element.

b. Horizontal movement caused by catching a hull projection on a lateral fender edge. Again, movement of the vessel may result in breakage of chain anchors, chains or brackets and finally the rubber element.

2. Continuous, cycling of buckling-type fenders

The hysteresis inherent in all rubber products generates heat with each deflection. The amount varies with the deflection rate, the rubber compound and the shape of the reaction vs. deflection curve. This is primarily a concern where berths are exposed to continuous swells that are more or less perpendicular to the berth face. The continuous, cyclic deflections cause a gradual heating of the fender body to the point of internal, structural failure. This problem increases dramatically as fender dimensions increase. It is most common in offshore or in exposed berths. The only solution is to find ways to eliminate constant cycling. A few hours at a time, with a day or more cooling time may be workable. Cycling 15 hours a day will lead to failure in a few months to a handful of years.

Most other failures fall into the category of improper manufacturing methods, with greater frequency every passing year, but they are seldom catastrophic, progressing over an extended period of time. They are avoidable, but unfortunately, there is no effective way to insure against them. Invariably, this situation is caused by the desire to produce a less-expensive fender. Furthermore, the realities of the market are such that this situation will persist as long as customers accept short rubber element life (roughly, less than 15 years). The only solution is not to buy replacements from the same manufacturer (not necessarily the same thing as the name on the product).

Maximizing useful life

Other than proper rubber specification, the most effective strategy to ensure the long life of rubber fender elements is to design fender installations that eliminate or dramatically minimize the possibility of fender 'hooking', which the specifying engineer has total control over. Doing this requires nothing more than common sense. Because this seems so simple, it is all too often dismissed, but it is the simplest and most effective means of improving useful life. The simple tricks that you develop to do this will not necessarily increase cost, and can often decrease not only manufacturing costs but installation and repair costs. There is not room here to list all the possibilities – they don't require special knowledge of rubber or fenders.

Conclusions

The up side to all this is that, just like energy calculations, no matter how bad some fenders may be, they seem to give adequate enough service for the marketplace. However, the long-term quality of mass-produced fenders looks destined not to improve. Good design can significantly increase the percentage of potential useful life that fenders actually achieve.

ABOUT THE AUTHOR

Ed Kiedaisch is Technical Director of Hi-Tech Marine Solutions LLC, and has over 28 years experience in the design of fenders and fender systems of all types, rubber compounding and testing and fender performance testing. He was involved in writing Appendix A, 'Procedure to Determine and Report the Performance of Marine Fenders' of *Guidelines for the Design of Fenders Systems: 2002*, published by the International Navigation Association (PIANC), and Standard F 2192, 'Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Fenders', by ASTM International. He has conducted 22 fender design seminars in the USA, Canada and Chile.

ABOUT THE COMPANY

Hi-Tech Marine Solutions designs and sells fender systems for all applications. Its primary market focus is the Western Hemisphere, but it has worked on projects on five continents.

ENQUIRIES

Hi-Tech Marine Solutions LLC
801 Main St., Suite 1C
Keokuk, IA 52632
USA

Tel: +1 (319) 524-4315
Fax: +1 (319) 524-4316
Email: ed@hitechusa.net
kfci@mac.com