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To:	All Surveyors/Auditors
Applicable to flag:	All Flags
Subject:	**Steel Structure - Strength and Toughness**
Reference:	**CONARINA Class**

Steel Structure - Strength and Toughness

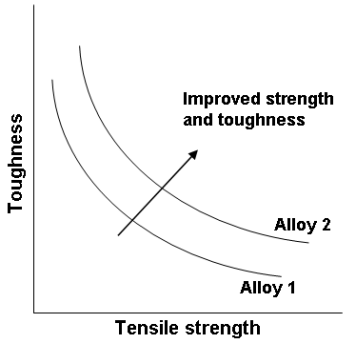
For structural components exposed to fatigue conditions, designers must be concerned with both the strength and the toughness.

Strength is a measure of the stress that a crack-free metal can bear before deforming or breaking under a single applied load. Fracture toughness is a measure of the amount of energy required to fracture a material that contains a crack. The tougher the material, the more energy required to cause a crack to grow to fracture. For a particular alloy, lower fracture toughness corresponds to less ductility. For example, glass has very low toughness and is very brittle.

For a component with a crack of a particular length, as the fracture **toughness** decreases, there is a decrease in the component's ability to withstand its load before fracturing. Conversely, for a certain load, as the fracture toughness increases, a component can tolerate a longer crack before fracturing. As shown in the figure below, for any particular alloy, the toughness decreases as the tensile strength increases. Consequently, when high toughness and high strength are both required, it is often necessary to change from one alloy to a different alloy that satisfies both requirements.

Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

Technical Head Office
7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (832) 451 0185,
1 (713) 204 6380
E-Mail: cbozenovici@vcmaritime.com



Strength Vs Toughness

Designers are often tempted to use a material that is as strong as possible to enable them to minimize component cross-section. However, this can inadvertently lead to using a material with insufficient fracture toughness to withstand fracturing if a small crack forms in the material during component manufacturing or during use. Fatigue stress is one possible cause of cracks.

The formation of cracks in components exposed to fatigue conditions is often expected. In these situations, knowledge of the fracture toughness is required to determine how long the component can remain in service before a crack grows so long that the intact cross-section of the component cannot support the load, and the component fractures. This applies maritime structures and pressure vessels such as boilers.

For structural components exposed to fatigue conditions, designers must be concerned with both the strength and the toughness. The strength must be large enough so that the material can withstand the applied loads without deforming. The toughness must be sufficient for the metal to withstand the formation of fatigue cracks without failing catastrophically.

REFERENCES:

- CONARINA Class

ATTACHMENTS: No.

Kindest Regards,
Cosmin Bozenovici
Naval Architect – Conarina Technical Head Office

Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

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Tel: 1 (832) 451 0185,
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E-Mail: cbozenovici@vcmaritime.com