



208-1497 Admirals Rd
Victoria, BC V9A 2P8
Canada
+1 250 920 9992
+1 250 483 6301

MEMORANDUM

To: James Adams, P.Eng. Project Manager, British Columbia Ferry Services Inc.
From: David Mietla, P.Eng. President, 3GA Marine Ltd.
Prepared By: Shaun Wallis, EIT Marine Systems Engineer, 3GA Marine Ltd.
Date: 2022-03-09
RE: Baynes Sound Connector Temporary Cable Replacement Analysis for LR Review

EGBC PERMIT TO PRACTICE No.
1001132



The Baynes Sound Connector was originally designed to run on three 1-5/8" plastic valley filled ropes with a breaking strength of 263,925 lbs. Due to environmental issues with the plastic valley filled ropes, in 2019 BC ferries started transitioning their ropes to all steel cables. The current ropes have a diameter of 1-5/8", a 285,000lbs breaking strength and a 6x25B flattened strand construction. They are finished with a proprietary Bezinal 3000 (95% zinc, 5% aluminum) coating similar to galvanization.

s. 13

As the new ropes do not have the plastic protection, they are wearing faster then before. [REDACTED]

[REDACTED] There are also several factors contributing to procurement issues including, the requirement for an extremely long continuous strand, an uncommon rope diameter, and global supply chain issues. Therefore, BC Ferries was required to look for alternative ropes that can be procured within the required timeframe and will not sacrifice vessel performance or safety.

3GA's analysis is to determine whether the proposed rope meets the operational requirements of the vessel.

Rope Strength Requirements

EYE, during the design of this vessel, performed a computational study to determine the required cable strengths. The results of this study have been included in Table 1.

Table 1: EYE report Table 8-2 shows the maximum loads predicted during the Time Domain Analysis

	Maximum Load kN	Factor of Safety	Minimum Breaking Strength Required kN
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

For further details on how these values were determined, refer to the EYE report “Dynamic analysis of cable ferry system Buckley Bay to Denman Island, February 2013”.

Analysis: Northern Strands Wire Rope

Diameter: 1-1/2”, breaking strength: 249,000lbs, 6XF125, supplied length: 10,000’

Lubricant: Dry, Finish: galvanized, Lay: Right Lang

The proposed rope has a 1-1/2” diameter opposed to the current 1-5/8”. 3GA does not expect any issues using a 1.5” cable. However, the sheave grooves are designed for 1-5/8” cable. The smaller cable may be subject to additional vibrations, potentially leading to excess noise and accelerated wear. BC ferries must continue executing quarterly inspections specifically looking for signs of accelerated wear, and any other unforeseen issues, caused by the reduced diameter. This information will be critical for future decision making. BC ferries will subject this rope to the same rejection criteria, already in place, for the existing ropes.

The EYE analysis during the “worst operation 55knots” condition determined a maximum load on the rope as 128,523 lbs (571.7 kN). The original plastic valley rope used for this vessel had a breaking strength of 263,925 lbs (1174 kN). This resulted as a 2.05 safety factor. This 1.5” rope has a minimum breaking strength of 249,000 lbs (1107.6 kN), which leads to a safety factor of 1.94. The EYE report required a safety factor of 2; this rope does not meet the EYE requirements for the “worst operation 55 knots” condition.

The EYE analysis also analysed a “100-year storm condition” which determined the maximum load when the vessel is subjected to 39 Knot winds, opposed to 55 Knots. For this condition, the maximum load on the rope is 96,533 lbs (429.4 kN). The proposed 1.5” rope has a minimum breaking strength of 249,000 lbs (1107.6 kN) which leads to a safety factor of 2.58. If BC ferries Limits their operational profile, to environmental conditions below the 100-year storm conditions, described in the EYE report, this rope is acceptable for use.

EYE has also specified a damage case with a max load of 155,342lbs (691kN) and a SF of 1.33. The proposed rope achieves a SF of 1.6 in this condition.

The EYE requirements were calculated using computational fluid dynamics software. As a result, there is no way for 3GA to validate the results. We do not have access to the software or the run files. Furthermore, we do not know the assumptions made, scenarios analysed, Or relative tensions on the ropes. 3GA only has access to the published results for max breaking load provided in the report. There is no way to explore alternative scenarios and conditions within their framework.

During the 2021 propulsion system upgrade, 3GA developed our own model to determine tensions in the cable. This model does not calculate the maximum load on the rope, like the EYE model, but is used to create a matrix of allowable pre-tensions, given a known cable strength. This model can be used to determine the operational parameters required to allow for one or all the cable(s) to be changed to this proposed 1.5” rope. Furthermore, the model uses a safety factor of 3 compared to 2, used for the EYE Analysis.

For additional confidence in this analysis, 3GA performed spot checks, using our model, to assure the cable will still have a reasonable range of allowable tensions. The spot checks were performed for the scenario where the north cable is replaced with this 1.5” cable. When setting both guide cables to 14 tonnes, there was no change in the allowable drive cable tensions. When setting the north cable to 14 tonnes and the south to 12 the range of allowable drive cable tensions went from 7.75-15.25 Tonnes to 11.25 -15.25 Tonnes. When setting the north cable to 12 tonnes and the south to 14 tonnes the allowable drive cable tensions remained unchanged. These results are shown in Table 2.

Table 2: Tension Matrix Spot Checks

Proposed Rope				Current Rope			
	South 14 Tonnes				South 14 Tonnes		
	T _d Min	Drift	Min SF		T _d Min	Drift	Min SF
	T _d Max	Drift	Min SF		T _d Max	Drift	Min SF
North 14 Tonnes*	7.5	92.32	3.4	North 14 Tonnes	7.50	92.3	3.88
	15.75	81.7	3.07		15.75	81.6	3.07
	South 12 Tonnes				South 12 Tonnes		
	T _d Min	Drift	Min SF		T _d Min	Drift	Min SF
	T _d Max	Drift	Min SF		T _d Max	Drift	Min SF
North 14 Tonnes*	11.25	94.26	3.04	North 14 Tonnes	7.75	96.1	3.01
	15.25	85.3	3.01		15.25	85.4	3.01
	South 14 Tonnes				South 14 Tonnes		
	T _d Min	Drift	Min SF		T _d Min	Drift	Min SF
	T _d Max	Drift	Min SF		T _d Max	Drift	Min SF
North 12 Tonnes*	7.75	96.16	3	North 12 Tonnes	7.75	96.1	3.01
	15.25	85.28	3.02		15.25	85.4	3.01

*North Wire strength 249,000lbs

This further confirms the ferry will be able to safely operate with the proposed cable installed, under the 100-year storm condition. It also shows it is best when the pretensions in all three cables are similar.

The lay of this rope is regular opposed to Lang. Lang lay ropes are known to have a large fatigue resistance rating and robust resistance against abrasion. However, for this application the difference in lay is likely negligible.

This rope is galvanized, so it will be more resistant to corrosion caused by the environment, compared to bare wire. The current rope is coated with a proprietary Bezinol 3000 (95% zinc, 5% aluminum) coating. The manufacturer, Briden, claims this product is far superior to standard hot dipped galvanization, but this is only a claim from the manufacturer. 3GA is not aware of any 3rd party reviews of these claims.

s. 13, s. 21

Conclusion

From the information provided in EYE's report and our own independent calculations, 3GA Marine Ltd. has determined the proposed Northern Strands 1-1/2" rope, with a breaking strength of 249,000lbs, is acceptable for use on the Baynes Sound Connector. However, the BC Ferries must change its operational profile to limit sailing to the "100-year storm" conditions outlined in the EYE report.

3GA does not expect any issues using a 1.5" cable. However, the sheave grooves are designed for 1-5/8" cable. The smaller cable may be subject to additional vibrations, potentially leading to excess noise and accelerated wear. BC ferries must continue executing quarterly inspections.