

Lesner Bridge Barge Impact Study

Scope of Work

Project Background – The Lesner Bridge is in the remaining years of its useful life. In the recent past, the City has implemented major rehabilitation efforts to slow the rapid deterioration of this structure. The current maintenance / rehabilitation program in place at the City is designed to keep the Lesner Bridge operating without weight restrictions until a replacement structure can be built (approximately 2015).

The Lynnhaven Inlet below the structure is a busy waterway that sees a variety of vessel traffic, both commercial and recreational. Over the years, both commercial and recreational vessels have hit the bridge. In most cases the vessel impact was with the protective bridge fender system. There has been concern about the effects of vessel impacts, particularly commercial, to unprotected portions of the bridge.

Planning is underway for the possible dredging of the Western Branch of the Lynnhaven River. As part of the dredging operation, a dredge spoil transfer station is being considered to be located south of the Lesner Bridge along the west side of the Lynnhaven Inlet, adjacent to the Lynnhaven Boat Ramp & Beach Facility. The barge traffic as part of this operation has renewed the concern about vessel impacts with unprotected portions of the bridge.

It is the intent of this Work Order to determine the possible effects to the Lesner Bridge should a barge become loose and adrift in the Lynnhaven Inlet and impact the bridge.

Scope of Work -

The Scope of Work involves the estimation of the barge impact forces, following with an analysis of the bridge structure being impacted by the established force(s). This will require, but not be limited to, the following:

- Estimate the water current within the Lynnhaven Inlet near the bridge area.
- Estimate the average barge size and weight used for the dredging operation.
- Determine impact forces based on established documents and formulas related to ship impact.
- Establish probable barge impact scenarios (direction and location).
- Analyze the bridge piers for the established impact loads and scenarios, including the analysis of the piers for the effect of possible loss of piles due to the impact.

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- Provide recommendations on possible bridge protection alternatives

Six (6) copies of a summary report will be submitted to the OWNER. The report will include an overview of all assumptions made, a summary of the study results, and all back-up computations used for the analysis.

This study does not address the probability of a barge impact.

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Initial Phase Executive Summary

A study has been conducted to determine the effects of a barge adrift impacting an unprotected substructure component of the Lesner Bridge. The following is a summary of the initial phase of the study.

- The study was conducted utilizing the AASHTO publications "Guide Specification and Commentary for Vessel Collision Design of Highway Bridges" and "Standard Specifications for Highway Bridges".
- The water current, and consequently the design vessel impact speed, was established from the NOAA Tides & Currents webpage, Lynnhaven Inlet Bridge, Predicted Tidal Current for the year 2008. The maximum predicted tidal current at Lesner Bridge for 2008 had a velocity of 2.0 knots (approximately 3.4 feet/second).
- The design barge was determined based on conversations with the City's dredging design consultant and some dredging contractors. Also, consideration was given to the width and depth of the navigable channel. The design barge was established to have an overall length of 81 feet, breadth of 27 feet, and a maximum draft of 4 feet (the design channel is 40 feet wide and has a depth of 5 feet at Mean Low Water). The displacement of the design barge was established to be 130 Long Tons (291,200 pounds); this displacement was based on the barge being loaded to a third of its full capacity.
- In accordance with the design procedures and requirements of AASHTO "Guide Specification and Commentary for Vessel Collision Design of Highway Bridges", the vessel collision energy was calculated to be approximately 55 foot-kips (for a head-on collision) with an associated vessel collision force of approximately 200 kips (1 kip = 1,000 pounds).
- A typical pile bent of the eastbound lanes of Lesner Bridge was evaluated for the established vessel collision force. A typical pile bent consists of a 3'-6" by 3'-6" cast-in-place concrete cap supported six 24-inch square prestressed concrete piles. The 200-kip vessel collision force was applied at an angle of 30 degrees to the longitudinal axis of the pile bent to the 24-inch square prestressed concrete pile at the south end of the pile bent. The force was applied to the pile 4 feet above Mean High Water. The analysis indicated that the pile will fail in shear for the vessel collision force. The concrete pile bent cap supported by the prestressed concrete piles was analyzed neglecting the failed pile at the end. The analysis of the concrete cap indicated that the cap will fail in flexure (bending) if support from the end pile is lost.
- Since failure of some bridge substructure components can occur if impacted directly by barges and other vessels, a bridge protection system (fender system) is recommended. In general, timber fender systems are cost efficient and effective. Evaluation of an appropriate bridge protection system is not part of the initial phase of the barge impact study.

Lesner Bridge Vessel Impact Study

Additions to Scope of Work

The original Scope of Work will be modified to include the following additional items:

1. Determine the maximum allowable vessel impact force that will not exceed the vessel impact capacity/resistance of the existing bridge. From this established vessel impact force, determine an associated maximum vessel size (displacement) and corresponding vessel impact speed.
2. Evaluate the operational aspects of the general vessel movements around the existing bridges with regards to the quantity, type, and size (displacement) of waterway traffic, and associated traffic patterns. The vessel types using the waterway shall be determined from vessel registrations with various regulatory agencies including but not limited to the Virginia Department of Game and Inland Fisheries, Virginia Marine Resources Commission, and U.S. Army Corps of Engineers.
3. Provide suggested guidelines for the operation of the vessels in the vicinity of the existing bridges in order to minimize the probability of a vessel impacting the bridges.
4. Provide conceptual recommendations for physically protecting the existing bridges (fender systems) from vessel impact due to the operation of such vessels in the vicinity of the bridges.

Items 2 and 3 will be accomplished with the assistance of Waterway Surveys & Engineering, Ltd.

The additional items above will be incorporated into the overall Barge/Vessel Impact Study Report.

October 3, 2008