

Replacing The Gull Rock And Little Bay Islands Navigational Sites

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ABSTRACT

The largest recorded hurricane to ever hit the province of Newfoundland and Labrador happened during the time span of September 20-21, 2010. After the destruction of the tropical cyclone was complete, the Canadian Coast Guard was responsible for assessing and fixing all damages caused to the provinces coastal navigational aids. While some sites were not damaged, others such as Gull Rock and Little Bay Islands had to undergo full structure replacement.

Gull Rock and Little Bay Islands are both very low lying isolated islands that had their helicopter pads washed away, while Gull Rock lost its navigational tower as well. It is important that all Canadian waterways be safe and easily navigated to meet the standards that the Canadian Coast Guard strives for. It was necessary to design and implement stronger structures in the area.

An analysis of waves in the area showed that the current structural designs were not braced properly in the horizontal direction. Larger timbers were chosen and braced in multiple directions for the helicopter pads, while the new navigational tower is a gravity-based design rather than a rock-anchored design.

The following paper will outline the hurricane damage assessment, the design and replacement of both the navigational tower and helicopter pads, as well lessons learned from the project.

1 INTRODUCTION

Little Bay Islands is a community located on the Northern coastline of Newfoundland and Labrador, Canada (49° 38' 50" N, 55° 47' 40" W). It consists of Little Bay Island, Macks Island, Goat Island, Harbour Island, and Boatswain Tickle Island.

Approximately 5 km Northeast of Little Bay Islands exists Gull Rock (49° 41' 00" N, 55° 41' 30" W), a small island that protrudes up to 6 m from the water surface.



Figure 1: Map of Newfoundland showing location of Little Bay Islands (Source: Google Maps)



Figure 2: Map of Little Bay Islands showing location of Gull Rock (Source: Google Maps)

Little Bay Islands and Gull Rock are both isolated Canadian Coast Guard (CCG) navigational sites consisting of a navigational aid tower as well as a helicopter-landing pad. During a navigational site assessment after Hurricane Igor struck the Island of Newfoundland it was reported that the tower and helicopter pad were missing from Gull Rock while the helicopter pad on Little Bay Islands was heavily damaged. It was apparent that the structures were not designed to withstand the forces created by the powerful storm.

2 HURRICANE IGOR

Hurricane Igor was the most destructive tropical cyclone on record to ever strike the Island of Newfoundland. During the span of September 20-21, 2010, stations across the Island, as well as offshore, were monitored for rainfall, wind speed and/or wave height. A confirmed maximum of 238 mm of rain fell, sustained winds reached speeds of 103 km/h, gusts peaked at 172 km/h, storm tides were measured at 1.1 m while immense weight heights were measured at 25.5 m offshore.

2.1 The Canadian Coast Guard

Although the majority of the publicized damages after the storm focused on isolated communities, road damages and personal infrastructure losses, The Canadian Coast Guard, more specifically Maritime and Civil Infrastructure (MCI), had a major challenge ahead of them. The CCG is a Special Operating Agency of Fisheries and Oceans Canada. As such, the CCG plays a vital role in the protection and maintenance of all Canadian waterways.

MCI is an engineering branch of the CCG responsible for installation, maintenance and decommissioning of all navigational and communications sites located across Newfoundland and Labrador. The variety of communication and navigational aids provided by MCI and the CCG as a whole is vast. The Newfoundland and Labrador region of the CCG is responsible for the placement of over 800 floating navigational aids that are supplemented by several hundred more fixed aids monitored by MCI.

2.2 Provincial Damage Assessment

The CCG operates on a certain code that establishes the quality that each of its sites must meet, thus, after the storm had dissipated a plan needed to be formulated to assess the damage caused by Hurricane Igor. The fleet of CCG boats was responsible for determining the harm done to all floating aids, while helicopter and ground teams were assembled to do the same for all fixed aids.

After several months of fieldwork, all damage had been established. Over one hundred sites were inflicted damage due to the storm however, only two sites lost infrastructure completely, Little Bay Islands and Gull Rock.

3 GULL ROCK TOWER REPLACEMENT

The construction of the new tower on Gull Rock began in May 2011. The tower design was completed in December 2010 but due to weather restrictions, employees and materials could not reach the site during the winter months.

3.1 Failure of Original Tower

The original tower present on Gull Rock was a rock-anchored design. This design involves the connection of a high strength guy wire from the tower to a concrete filled hole drilled in the rock surface. Guy wires are connected in at least four directions to sustain all forces.

Upon inspection of the failure it was noted that the rock surface was not able to withstand the forces created at the guy wire base, fractured and ultimately created no resistance to the tower being washed away.

3.2 New Tower Design

A gravity based tower design was the optimal choice for Gull Rock. Gravity based structures involve installing a large concrete block for the tower foundation rather than depending on the rock surface present. First a large hole was blasted in order to build the formwork. Within the formwork, reinforced steel was placed and twelve high strength metal rods were strategically set vertically for tower connections. Concrete was then poured, leaving only a portion of the connection rods above the surface. After a period of seven days, the formwork was removed and the tower was placed.



Figure 3: Formwork for Concrete Block Before and After Pouring (Source: Canadian Coast Guard)

High strength grout was then placed on the concrete surface at the base of each rod and the new aluminum tower was crane lifted into place. High strength stainless steel bolts were then attached to keep the tower from any uplift forces. After the quick dry grout sets within an hour the tower was fully installed.



Figure 4: Implemented Gravity Based Tower at Gull Rock (Source: Canadian Coast Guard)

4 GULL ROCK AND LITTLE BAY ISLANDS HELICOPTER PAD REPLACEMENT

Shortly after the tower was erected on Gull Rock, the Canadian Coast Guard team began work on the installation of the new helicopter pads. The helicopter pads are of major importance as they are the only way to access the sites besides a boat.

4.1 Failure of Original Helicopter Pads

Shortly after the inspection of the sites began it was realized that the helicopter pads were not braced properly in the horizontal direction. It was determined that the failure occurred gradually over time and the storm waves were the final mode of failure.



Figure 5: Horizontal Failure of Helicopter Pad Supports (Source: Canadian Coast Guard)

4.2 New Helicopter Pad Design

The new helicopter pads were a focal point of the replacement operation as the helipad was a brand new design. It had to support both lateral and vertical forces without relying on the original rock for assistance. The final design was implemented in the following phases:

Phase 1: Nine holes, 24'' in diameter were busted out from the rock surface. Each hole was equipped with a circular steel bracing. Within the bracing a large steel rod was placed through the center and two metal plates were installed at the edges, both held in place by stirrups. Concrete was poured inside the bracing and cast for seven days.

Phase 2: 2'' x 4'' timber was attached from each steel braced pier to the next closest pier on two separate sides by drilling a hole through the timber and the steel bracing then connecting the two to the previously installed metal plates with large stainless steel bolts. This mode prevents the pad from failing in the horizontal direction.

Phase 3: A square frame was created out of 4'' x 4'' timber on the tops of each pier. The frame was supported by six 2'' x 4'' cross bracings (long direction vertical). Upon the square frame a second layer of 4'' x 4'' timber was installed and 2'' x 4'' timber was then placed across the second frame creating the top deck of the helicopter pads (long direction horizontal). The timber is supported by metal bracing at each edge completing the helicopter pad installation.



Figure 6: Figures illustrating the Phases of the Helicopter Pad Replacement (Source: Canadian Coast Guard)

5 CONCLUSION

The after effects of Hurricane Igor were very eye opening for the Canadian Coast Guard. Since the installation was completed at Gull Rock and Little Bay Island there have been many investigations into various other sites throughout the province. Each and every site has had its navigational tower and helicopter pad (if applicable) assessed for degree of damage. Funding has been awarded annually to Marine and Civil Infrastructure to fix the sites as needed. MCI's goal is to replace all rock-anchored towers with gravity-based towers and insure that all helipads are properly braced. It is estimated that by the end of 2013 even the lowest risk areas and least damaged structures will be replaced insuring that if a storm of that magnitude hits again, the provinces water navigation will be fully prepared for it.

REFERENCES

- [1] Canadian Coast Guard, "Gull Rock Tower Replacement", 2011
- [2] Pasch, Richard J, "Hurricane Igor (Tropical Cyclone Report)", 2011