

# Car Ferry Service Between Prince Edward Island and New Brunswick.

By A. K. Kirkpatrick, M. Can. Soc. C.E., Professor of Civil Engineering, Queen's University, Kingston, Ont.

The various routes examined between Prince Edward Island and the main land of New Brunswick, with a view to establishing a car ferry, are as follows: Richibucto to West point, Richibucto head to West point, Buctouche to West point, Shediac or Pointe du Chene to West point, Shediac or Pointe du Chene to Summerside, Cape Tormentine to Summerside, Cape Tormentine to Carleton head, Pugwash to Carleton head, Pugwash to Charlottetown, Wallace harbor to Charlottetown, Brule harbor to Charlottetown, John bay, Amet sound to Charlottetown, Pictou to Georgetown, Pictou to Murray harbor, Pictou to Charlottetown, which will be taken up separately.

**ICE CONDITIONS.** The bord or shore ice forms at all ports and will be taken up when considering each harbor, as it varies in each case, due to the configuration of the shore, depth of water, and exposure.

The pan, rafted, berg, gulf, and lolley ice may be considered under one head, although it varies in quantity in the different places, due to the tides, winds, and shape of the shore, etc.

Pan ice, being the areas of flat ice which forms in the straits and drifts back and forth with the tides and wind, and varies in thickness 6 to 20 ins., would not prove a serious obstruction to a car ferry built on ice-breaking principles.

Rafted ice, or piled ice, is the ice that is piled one cake upon another, usually at the outer edge of the bord ice, where a large field of pan ice, under motion due to the winds and tide, meets an obstruction in its path, such as the edge of the bord ice. Rafted ice may be formed between two large fields of pan ice of which one or both are in motion. The pan cannot be stopped at once, and the immense force behind drives the ice in front, on top, and under the bord ice, in some places grounding in 25 ft. of water, and piling up 10 or 12 ft. above water level. If this takes place at low temperature, this piled ice is frozen into a solid mass.

The rafted ice usually forms at headlands, and grounds on the reefs extending out from the headlands, forming a protection to the bord ice under the lee. It also forms at the edge of the bord ice on straight stretches or bays, where there is sufficient fetch to permit the field or heavy pan ice to get in motion due to the heavy wind, therefore not necessarily forming to the same extent in the same place each year. This rafted ice forms some of the objections of the proposed terminals, and the overcoming of these difficulties may be provided for in the design of the vessel.

Berg ice is only encountered in the spring, when the break up occurs, and is chiefly composed of the rafted ice along the bord ice, which piles on the reefs, breaking loose and drifting with the tide. The evading of these is a matter of navigation.

Gulf ice may be encountered after the break up occurs, and chiefly consists of heavy fields of pan ice, bord ice and rafted ice, from along the shores of the gulf, breaking loose and being driven by the winds into the tidal currents of the straits.

Lolley ice, though not dangerous to navigation, which may slow down the speed of a large steamer, for which provision has to be made in designing the details of the engines, is encountered in the Northumberland strait when the weather is favorable to its formation. From a rough examination of the crystals, and inquiring as to the

conditions of the weather previous to its appearance, I conclude that it is a mixture of anchor and frazil ice. It appears in the form of a heavy dense slush, and sometimes to the depth of 10 or 15 ft., and is buoyant enough to bear up a man when standing on an oar or a plank placed on the ice. The frazil ice crystals are probably formed in the cold water when the temperature of the atmosphere is very low, and a wind stirs the water surface and prevents the surface ice from forming.

The anchor ice, with its sponge like form, is formed on the bottom during very cold, clear nights when the radiation is great. When the sun rises high and its rays penetrate to the bottom, it frees the masses formed, or they break away from the bottom owing to the force of the current.

The ice drifts back and forth with the tide and wind, but the preponderance of the drift is eastward. The young ice forms in the western portions of the straits, and eventually fetches up in the eastern end of the straits, and gains in thickness from snow and frost as it ages.

24 ft. of water would be required at this entrance across the bar. This depth would be difficult to maintain, on account of the littoral drift, also the stopping of the drift to the west of the breakwater is eventually going to weaken the sand beach to the east of the jetty if built, and cause a break, which will weaken the ebb and flow through the channel on which it would rely for its maintenance. This harbor would be very difficult, if not impossible, to make in a north to northeast gale and an ebb tide, on account of the sea and shoal water. Once inside there is a good protection and plenty of water. Good position for a slip could be secured, and when once dredged could easily be maintained.

AT RICHIBUCTO HEAD, N.B., the bord ice forms at from 1,000 to 1,500 ft. out from the shore, and is liable to heavy rafted ice on account of the exposure. Gulf ice may be met with in the latter end of March and April, when the winds are favorable for its movement to this point. This occurs occasionally, not annually. An artificial harbor, as well as about nine miles of rail-



Car Ferry Marquette and Bessemer No. 2, Forcing Through Piled Ice, on Lake Erie.

The littoral drift is principally southward and eastward, due to the prevailing winds and configuration of the shore, and in developing some of the harbors along the straits the littoral drift has to be seriously considered when designing permanent improvements.

**RICHIBUCTO HARBOR, N.B.** Bord ice forms only a short distance out from the entrance, and is liable to go out a couple of times during the winter, depending on the direction and force of the wind, and on account of its exposed position. A north to northeast wind, with a large field of pan ice, is liable to cause heavy rafted ice across the entrance. The ice in the harbor makes to the depth of from 18 to 24 ins. The old entrance to the east is now partially closed and has only about 10 ft. of water over the bar at low water, and it is only a matter of time until it will be completely closed by the littoral drift. The new entrance to the east of the breakwater may be improved by the construction of a jetty, but on account of the exposed position at least

way, would have to be constructed, including the bridging of the Richibucto river, if it were to be considered for one of the termini of the car ferry service. The bord ice forms as far out as the outer bar, and sometimes rafts heavily at this point, and is liable to go out a couple of times during the winter, depending on the wind and tide. East and west breakwaters would have to be built, enclosing a sufficient area to allow for the manoeuvring of a large vessel, and the exposure that it has and the distance required to go out to get deep water, would make this proposition a very expensive one, and with a northerly gale it would be a question whether the harbor could be entered.

**BUCTOUCHE HARBOR, N.B.,** is protected by a sand beach, along the shore of which there is considerable littoral drift. The entrance is at the east end of the spit and is obstructed by a stone ledge upon which there is only 12 to 14 ft. of water at low tide. There is also an outer bar of sand, on which there is only 14 to 18 ft. of water at low tide. All that can be counted on in the