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Ice control in river harbors and fleeting areas

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RIM
RIVER ICE MANAGEMENT

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Ice control in river harbors and fleeting areas in the northern tier of the United States east of the Mississippi River is handled mainly by the barge and towboat companies. Fleeting area protection in many locations is provided by ice piers and mooring cells. When possible, unused barges are anchored in side channels and below islands or set along one side of the waterway in large groups for ice protection. Icebreaking is done by towboats, without barges, and a wide track is broken out. Alternative methods of ice control are discussed.

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PREFACE

This report was prepared by Roscoe E. Perham, Mechanical Engineer, Ice Engineering Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory. The study was funded under the River Ice Management Program, Work Unit CWIS 32296, *Ice Control in River Harbors and Fleeting Areas*.

The author was assisted in gathering field data by Edward Foltyn of CRREL. The report was technically reviewed by Kevin Carey and James Wuebben, also of CRREL; their comments and guidance were much appreciated.

CONVERSION FACTORS: U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

These conversion factors include all the significant digits given in the conversion tables in the ASTM *Metric Practice Guide* (E 380), which has been approved for use by the Department of Defense. Converted values should be rounded to have the same precision as the original (see E 380).

Multiply	*By*	*To obtain*
foot	0.3048	meter
mile	1609.347	meter

Ice Control in River Harbors and Fleeting Areas

ROSCOE E. PERHAM

INTRODUCTION

Ice control in river harbors and fleeting areas was of interest to the U.S. Army Corps of Engineers as part of the River Ice Management (RIM) program. This report looks at some of the effects of Corps ice management activities on shore facilities in river harbors and fleeting areas and on river bank facilities in general, and the effects that navigational use of these facilities has on the success of ice management. In addition, this report recommends methods of reducing any adverse effects both on ice management, on the one hand, and on shore facilities on the other.

The region of study is shown in Figure 1. An example of a fleeting area in winter is seen in Figure 2, an aerial photo taken at Hennepin, Illinois, on the Illinois River. The fleeting area takes a portion of the river width. The series of barges helps to anchor the ice cover, but they are out in the main stream where they might be moved and damaged by ice. Safer places for them are enclosed harbors, sloughs or downstream of islands. An example of a special problem area is shown in Figure 3. This is a water level view looking upstream at a 167-ft-wide passage between bridge piers at Ottawa, Illinois, on the Illinois River. The Fox River tributary enters from the left, approximately 1700 ft upstream of the bridge, and causes some crosscurrents that the tow pilot must adjust for. The two features, a narrow gap and cross currents, in conjunction with winter ice, poor visibility and windy conditions, make for a difficult and dangerous passage. A wide path is broken in the

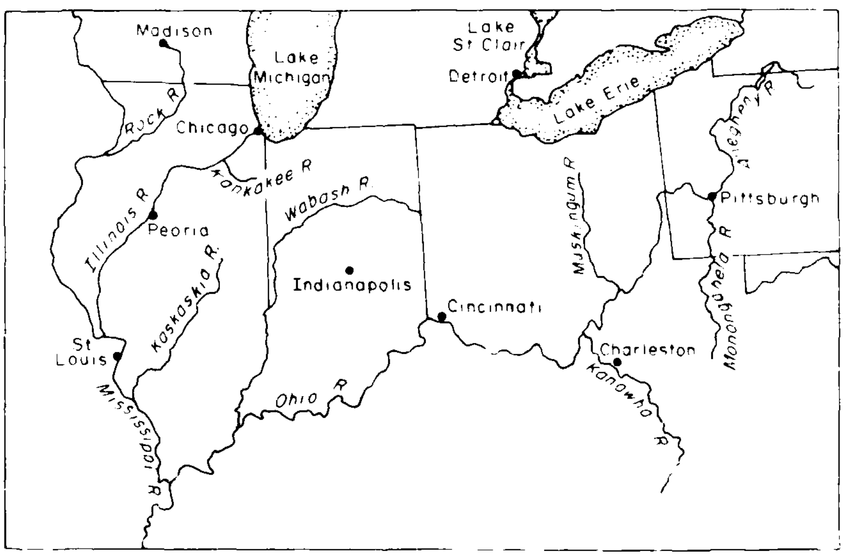

Figure 1. General region of study, east-central United States.

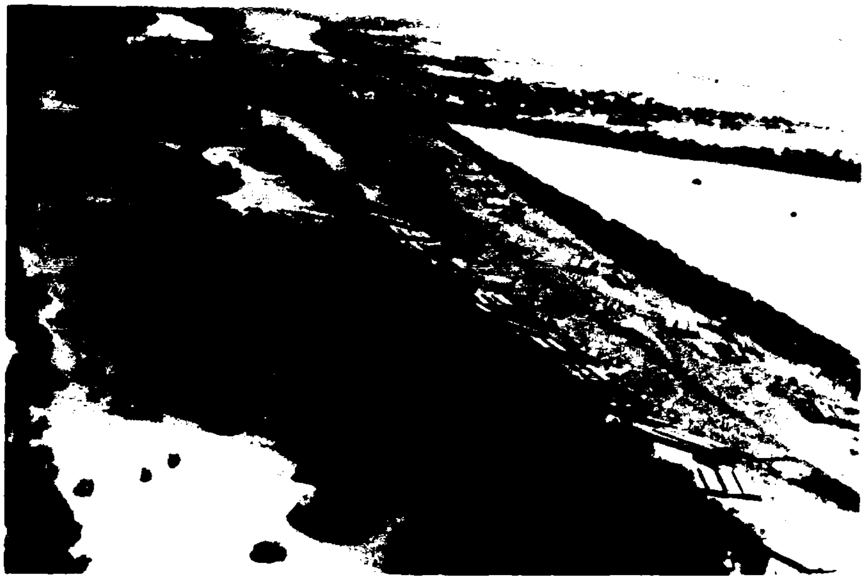

Figure 2. Aerial view, looking upstream, of a barge fleeting area on the Illinois River at Hennepin, Illinois.

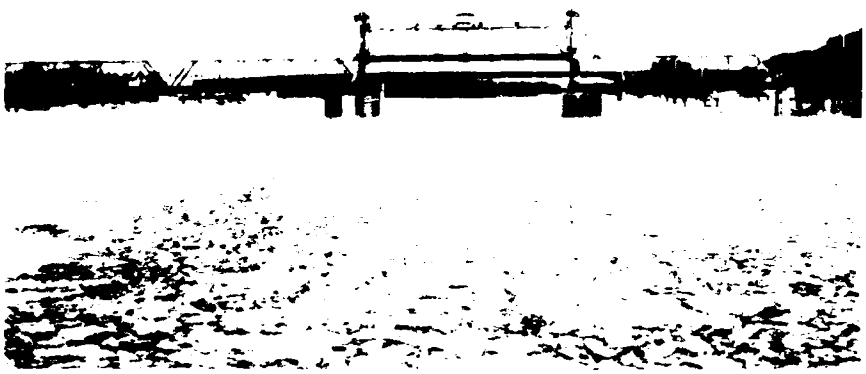

Figure 3. Water level view, looking upstream, of the ice-covered Illinois River at Ottawa, Illinois and the New Hilliard Highway bridge.

ice above and below the bridge to facilitate maneuvering through this gap. The broken ice moves downstream to accumulate in some other reach where, in time, another type of problem may develop.

Sources of information

The information for this report came primarily from visits to many river facilities on the Allegheny, Monongahela, Ohio, Kanawha and Illinois Rivers. Discussions were held mainly with Operations Division personnel of the U.S. Army Engineer Districts, and tow and barge company operators.

A modest amount of information was available in the literature, but most of that from foreign sources was only partially applicable in the U.S. because of the differences in ice management, economics, winter severity and shipping methods. The report by Tronin and Pushkarev (1979) is an interesting dissertation on how ice management is conducted in the Soviet Union. There, the river icebreaker is the key vessel; it breaks out the ship track, flushes ice out of the ferry track and carries out many other tasks. Also the barges there generally are pulled through the ice, not pushed as they are in the U.S. Additional information is available in the various reports produced by the Winter Navigation Demonstration Program on the Great Lakes and St. Lawrence Seaway (Great Lakes and St. Lawrence Seaway Navigation Board 1977, 1979).

Agencies responsible for aspects of navigable rivers

McCartney (1986) compiled a list of parties responsible for the various components of navigable waterways in the U.S. The Corps of Engineers has under its jurisdiction:

- Channels.
- Locks and dams.
- River training works.
- Relocations caused by construction.
- Special features, such as ice-control structures or bridge pier protection works.

Local government or private industry are in charge of harbors and barge fleeting areas. And the U.S. Coast Guard is responsible for:

- Aids to navigation.
- Icebreaking.

In addition, the Corps is responsible for reservoir regulation on the tributaries, which of course is important in maintaining pool levels; also, under certain circumstances, the reservoir discharges can affect ice cover integrity.

The Corps has a few harbors and anchorages used to dock, store and maintain Corps equipment. But except for its permits section, the Corps has no control over anchorages. The Coast Guard carries this responsibility. Also, the Coast Guard is responsible for dealing with an oil spill, whether in a harbor or elsewhere.

The Coast Guard is expert at deep-water icebreaking. However, it does not have shallow draft icebreakers nor the expertise to break ice in the shallow draft waterways; therefore, icebreaking on those waterways is done almost entirely by private companies employing towboats without barges. This includes any icebreaking in the river harbors and fleeting areas and at the river bank facilities in general. The towing industry wants to protect the barges and keep them from breaking loose, and to keep traffic moving. If ice jamming threatens to disrupt things, towboats will try to break up the ice.

EXAMPLE SITUATIONS

Examples of two river harbor and fleeting areas are described below. They are small harbors with few facilities; the photographs of these locations describe the ice situation quite well. The first area may be characterized as a source of moving ice and the second area as a repository of broken ice.

Kanawha Harbor

Figure 4 is an aerial view of Kanawha Harbor, looking upstream, at mile 1 on the Kanawha River, a tributary of the Ohio River (mile 265.5). It is a small harbor and the navigation charts call for fleeting harbors on both sides of the river. Kanawha Harbor as such is on the left descending bank (right side of Fig. 4) and five empty coal barges, two covered hopper barges and two petroleum barges are seen anchored there. Immediately upstream of the barges are three ice piers that divert moving ice and reduce ice pressures in the near-shore area.

The ship tracks are quite visible in the snow-covered ice and one can see that the barge tows enter and leave the harbor at a shallow angle to the channel line. There are large ice floes (in the center Fig. 4) that seem to be on the verge of moving should something disturb them, such as an in-

Figure 4. Aerial view, looking upstream, of Kanawha Harbor on the Kanawha River, 1 milc upstream of its confluence with the Ohio River. The effects of barge and tow maneuvering on the ice cover are readily seen.

crease in water flow, a rising wind or a ship passage. The conditions here are not troublesome, but when a lot of ice like this moves downstream, problems can develop in other areas. I think that the series of barges anchored on the opposite shore helps to anchor the ice sheet on that side of the river. Although Kanawha Harbor is very small, it experiences the same kind of ice breakup as do the larger harbors, but less frequently, and probably on a smaller scale.

Chillicothe Harbor

A harbor that is especially prone to becoming clogged with ice is at Chillicothe, Illinois, at mile 180-181 on the Illinois River. Here there is sufficient flow to move broken ice downstream until it reaches the slackened water of Peoria Lake, where the stationary ice stops the moving ice. As the ice continues to collect at Peoria Lake, a zone of stationary ice moves up into Chillicothe Harbor. Icebreaking towboats work on the accumulation, pushing it out of the channel and over to the side of the river. This method helps barge traffic for a while, but a continual influx of ice can eventually lead to a continuous ice jam from one side of the river to the other. In extreme cases it may take two towboats working together to push one barge through the harbor area.

Figure 5 is a view looking downstream from the Chillicothe public ramp; a grain elevator chute and barges tied up to timber dolphins are seen on the right bank; to the left, over most of the river, is a deep accumulation of well-churned and mixed broken ice. The accumulation is several feet deep and has approximately the same characteristics from one side of the river to the other. At the time of this photograph, 23 January 1985, winter navigation had virtually stopped though this reach because of the ice jam. Fortunately, no flooding develops here because the left bank of the river upstream is low, and the blocked flow moves over the bank into Rice Lake and then around Chillicothe Island (U.S. Army Corps of Engineers 1968).

Figure 5. View of Chillicothe Harbor, Illinois, looking downstream and across the Illinios River. The ice accumulation in this harbor at the time this photo was taken is too deep to permit navigation.

DISCUSSION

Shallow draft waterways

Ice problems, such as those desribed for Chillicothe Harbor and others, are caused by things over which the Corps of Engineers has little or no control. The Corps maintains water levels at navigation dams, and when the river flow increases for some reason, usually from rainfall, Corps personnel must pass the water and often the ice along downstream because there is little capacity for storing water in the pool. When the water levels increase substantially in the river harbors and fleeting areas, the barge fleet and boat anchoring equipment must make an appreciable adjustment for these increases. Sometimes, when ice is passing through a harbor area, a barge or several barges will be torn loose from their moorings; this happened on 30 January 1978, a few miles upstream of Racine Lock and Dam at mile 237.5, on the Ohio River, during the time of the Markland Dam ice jam (U.S. Army Corps of Engineers 1978). The owners and users are responsible for retrieving the barges and, more importantly, for preventing damage to the dam gates and the potential loss of the navigation pool.

The most important method for protecting an anchorage is to deflect moving ice around it by using ice piers, a drift deflector, or a barge or tow boat set at an angle against the shore. Figure 6 shows a sketch of this arrangement. The icebreaker has its engines and propellors operating and its rudders set to keep the moving ice from pressing its stern against the shore.

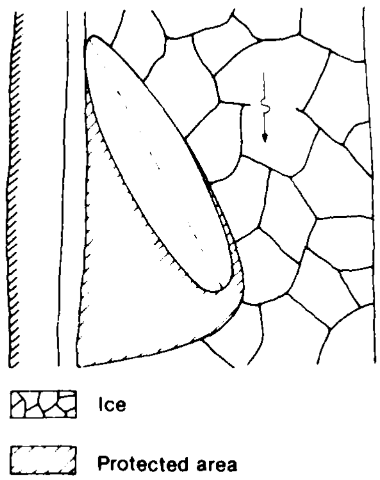

Figure 6. Mooring a ship to deflect ice during ice movement on a navigable river in the Soviet Union (after Tronin and Pushkarev 1979).

Remedial work at a deep-water harbor

Several ice-related problems developed on the St. Marys River in northern Michigan. These problems were studied extensively as part of the Winter Navigation Demonstration Program on the Great Lakes and St. Lawrence Seaway (Cowley et al. 1977), and methods to overcome most of the problems were devised.

The main problem was that ship operations, which in winter consisted mainly of ore boats, broke up large areas of the ice cover within the harbor at Sault Ste. Marie, Michigan (Soo Harbor), and in the associated ship channels. Ice continually accumulated in the ship track downstream and in the docks of a ferry boat that operated year-round.

At times ice accumulated so deeply in certain parts of the downstream channel (Little Rapids Cut) that the flow restrictions would lead to flooding in Soo Harbor. To counteract these effects, an ice boom containing a navigation opening was installed at the outlet of Soo Harbor (Perham 1977). The boom worked very well, but it had some ice loading problems that were corrected by adding two artificial islands upstream of the boom to prevent ice sheet rotation. The icebreaking and ice moving duties, which were an important part of the overall control of ice, were carried out by U.S. Coast Guard vessels such as the 305-ft long *Mackinaw* and the 140-ft *Katmai Bay*. The Coast Guard could help in this case because Soo Harbor is deep enough.

To solve the problems for the ferry boat, it was strengthened against ice pressure, given more power and its two docks were provided with air discharge devices that shoved brash ice out of the ferry slip so that the boat could enter.

RECOMMENDATIONS

1. When permits are given for the construction of piers, wharves and other harbor and fleeting facilities, consideration should be given to whether or not they will reduce the hydraulic capacity of the river and whether or not the proposed facilities will increase the amount of loose, moving ice in the river. These effects should be avoided, especially in such locations as upstream of Peoria Lake and downstream of Marseilles Lock and Dam on the Illinois River.

2. The Corps of Engineers should communicate periodically with the U. S. Coast Guard to ensure that appropriate anchoring techniques and equipment are being used by the barge and tow industry in reaches where loose barges can damage the locks and dams.

3. Government agencies should continue to provide up to date information on ice conditions and ice movements to the barge and tow operators. These data should come from aerial views and ground-level observations made by experienced operations personnel.

4. The number of fleeting areas that have traffic in and out of them during the months when a river is ice covered should be kept to a minimum to decrease the amount of free moving ice in the river.

5. Locations along a river where border ice continually enters the ship track because of normal barge operations, water flow changes and atmospheric disturbances (and not aggressive icebreaking techniques) may be good places for overwinter storage of empty barges as an ice stabilization technique.

6. In locations where the premature breakup of tributary ice could aggravate main stem ice problems, studies should be made of the associated reservoir outlets to ascertain the rates of flow that can be passed beneath the ice cover before it collapses. Should these discharges be appreciably lower than those needed for flood control, then ice cover reinforcement, channel enlargement or some other approach should be considered.

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