the United States withstands the average street load and is usually designed with 1 or 1¼-in. pipe embedded in a steel reinforced concrete slab 5 to 6 in. thick.

No sub-floor is necessary because of the steel reinforcing incorporated in the slab. However, a sub-floor is used when the floor is insulated.

Experience has shown that a few basic inexpensive designs have proved satisfactory over a long period of time. This refers particularly to sand fill and general purpose floors (Figs. 5, 6, and 7). In the United States, the Carpenter Monolithic Floating Floor and Piping System (Fig. 9) has proved to be an economical installation, especially when used for diversified activities such as exhibits, roller skating, tennis, boxing, and other events. Floors need not be insulated unless quick changeovers are desired or unless there is a basement under the floor.

Drainage. The suitability of the subsoil on which an ice rink is built has a great influence on its success. It has happened that a complete ice surface had to be rebuilt because of poor drainage and the ultimate heaving of the ice surface. Poor drainage and the failure of the ice surface may be a contributing factor in the failure of a number of rinks. It is not economical to build a skating rink on cheap, swampy, or low-lying land.

Moist subsoil will freeze in the ground to a depth of four feet or more. The frozen water will heave the ice surface when freezing takes place to a height of six inches or more. It creates an uneven skating surface, moves and raises walls, piers and header trenches, cracks walls and piping, and necessitates the eventual drainage and rebuilding of the rink floor. The correction of heaving on a 4-sheet curling rink (56 × 156 ft), when built on a soil containing silt, costs upwards of $25,000.

Not only should there be a complete drainage system around the footings of the rink to prevent seepage, but also under the rink surface itself. This is particularly important when sand fill floor is used to insure that the ice melted after the skating season will completely drain away and that the sand will dry out as quickly as possible.

If ground conditions, tide, or river levels make it impossible to assure a dry base under the rink surface, a general purpose floor on piers may be constructed. Whether insulation of the rink floor is required or not, will be governed by the prevailing temperature in the locality in which the rink is to be located. Condensation on the underside of the concrete should be avoided.

Preparation for rink floor. When built on natural ground, regardless of whether a sand fill or permanent general purpose floor is intended, proper preparation of the bed is important, unless the rink is built on elevated sand and gravel subsoil.

If the rink is to be built on clay, part clay or rock subsoil, it should be made certain that water cannot collect in the low points. The clay or rock should be excavated, or the rink level should be built up to a height of about 4 ft, with crushed stone and gravel, after which it should be well rolled. Water should not be used for settling the fill.

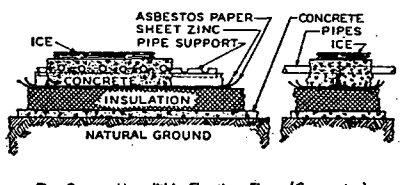

Fig. 9 .... Monolithic Floating Floor (Carpenter)

In the case of sand fill rinks, the quick drainage of the melted ice at the end of the skating season will insure quick drying of the sand and rink piping and result in longer life of the piping. In no case should cinders be used as fill in open sand fill rinks because of the possibility of sulfur in the cinders which, when damp, accelerates corrosion of the piping.

Care must be taken to insure a perfectly level surface over the entire rink.

Permanent general purpose rink floor. When constructing a permanent general purpose floor, the same precaution in regard to subsoil must be taken as for open sand fill rinks, and the concrete floor should be constructed to withstand loads of the average pavement. It is considered good practice to embed the piping in concrete at a uniform thickness all around the pipe. For 1¼ in. pipe when placed on 4½ in. centers, the total thickness of concrete should be 4½ in., plus ¼ or ⅜ in. cement, trowel or preferably terrazzo finish.

If other than 1¼ in. piping and 4½ in. spacing are used, a concrete subfloor may be necessary to carry the possible floor loads.

When local conditions make it advisable, the rink floor may be insulated, in which case a substantial, level subfloor must be constructed on which the insulation is laid.

The concrete mixture recommended is 3000 lb concrete and the work should be carried out only by an experienced and competent concrete contractor. Suitable cross reinforcing in addition to pipe supports is desirable.

The pouring of the concrete floor, once started should be continuous, including the top finish. It should be well tamped to insure complete contact between pipe and concrete.

General purpose rink floors should not be defrosted too frequently. When a rink constructed with a general purpose floor is intended to be used for purposes other than skating during the ice season, and an ice-free floor is required, it is preferable to place a portable section wood floor over the ice for the occasion and remove it after it has served its purpose.

All purpose floors. If a rink floor, as used in sports arenas, is to withstand the expansion and contraction of frequent frosting and defrosting, extra precautions must be taken in its construction. Provision must be made for the free movement of the freezing slab with respect to the subfloor.

Header trench. A well constructed concrete header trench of sufficient size to house the headers and connections is essential to permit access for periodic inspection and painting of the piping contained in the trench.

Headers and piping in the trench, or the trench itself, do not generally require insulation. The trench should have removable covers and be well drained to facilitate drying out.

Unless required for walkways, brine headers may be cast in concrete slab as part of the ice rink floor. Provision for purging air from tank piping must be made.

Snow pit. A snow melting pit should be provided at a suitable point, usually at one end of the rink. It should be of sufficient size to handle the scraped off snow, ice accumulated during planing, or to accommodate the complete ice removal.

Water from shell-and-tube condensers or hot water from some other source must be provided to melt the snow and ice. Hot water is always required when evaporative condensers are installed.

A large drain as well as an overflow should be provided as well as a large removable screen to remove trash.

BUILDING THE ICE SURFACE

Regardless of the type of rink floor used, when the plant is first placed in operation, the equipment should be operated long enough for a sharp frost to appear on the surface. Then the entire surface should be uniformly flooded with a fine spray nozzle. This process should be repeated until a ½ in. thickness of ice is built upon the concrete floor, or ¾ in. thickness on a sand fill floor.

The surface should not be frozen colder than required after this build-up, in order to temper the ice before it is used for skating and to prevent cracking.

Maintaining ice surface. To maintain an ice surface it is customary to scrape off the snow after each skating session or hockey period. For this purpose specially designed ice shovels are used. They should have a hardened steel scraper bar and be wide enough to enable two men to clear the snow off the rink in ten minutes. After this has been done, the ice is sprayed with hot water at about 180 F.

The most satisfactory method of spraying the ice between sessions is to use a sprinkler tank filled with hot water, which is wheeled over the ice. The sprinkler has an adjustable valve to control the quantity of water which is sprayed into a terry cloth bag that wipes the fine snow off the ice surface and fills the crevices cut by the skaters. In this manner the least amount of water is added, reducing the ice build-up and refrigeration load. Such sprinklers are usually used in pairs.

Automatic equipment for removing snow and sprinkling the ice is available.

Ice planer. A skating rink is designed for efficient operation of the mechanical equipment and provides thermostatic control for controlling the ice temperature within close limits to obtain a perfect ice surface. The floor contractor provides a perfectly level floor with adequate subsoil drainage. However, too often, due to incompetent ice making, improper sprinkling equipment, or deep cutting of the ice during public skating, the ice becomes uneven and excessively thick. There may be a variation of several inches in the ice thickness across the rink, but the resulting variation in the condition of the ice is more serious. In any case, the low spots must be built up, increasing thickness and refrigeration requirements.

For example, under assumed conditions where 18 F brine would be cold enough to hold a 1½ in. thickness of ice, calculations show that 7.5 F brine would be required if the ice be permitted to build up to 6 in., with a corresponding increase in the required compressor size.

Since ice of ½ to 1 in. thickness is satisfactory for skating and is the most economical thickness to freeze and hold, the ice should be periodically planed to maintain the desired thickness. Motor driven planers are now available which will remove ½ in. of ice from the average size rink in 40 min.

Ice shaver. In the case of curling rinks where, due to the normal making of ice, the ice sheet may become thick and dirty from use due to ashes, etc., a new ice shaver designed especially for curling rinks is now available which will remove the pebble and cut about ½ in. of ice at a time to maintain a clean and perfect surface. It is electrically or gas driven and light enough to be operated by one man.

FOG AND DRIP

In mild weather, particularly in early fall and late spring, rinks and especially curling rinks because they have no internal heat load, often drip from the roof and roof supports. The condensate dropping on the ice ruins the curling surface and the fog obstructs the view. These conditions cannot be solved by ventilation because the introduction of outside air only aggravates the problem when the weather outside is mild and humid. Insulating the roof also aggravates drip under mild outside weather conditions.

The same conditions may apply to skating rinks designed for small seating capacity, where the ice surface is relatively large in relation to the roof surface, and where there is little or no internal heat load.

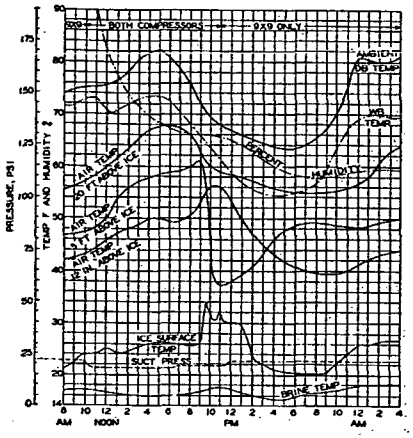

Fig. 10 .... Actual Log of Installation

In northern climates with the curling rink building designed for a maximum infiltration of one-half air change per hour and where the wet-bulb temperature does not exceed 60 F during the curling season, experience has shown that 43 F air temperature may be expected in the truss space with a 30 F ice surface temperature.

Under these conditions, to prevent condensation in the roof space and to clear the fog, it has been found that a six-pad curling rink would require the removal of 33 lb of moisture per hr, necessitating about 6 tons of refrigeration.

There are now available dehumidifying units, arranged for automatic electric defrosting, using the brine from the rink piping as the cooling medium, while others have separate Refrigerant 12 condensing units. A new self-contained air-cooled reverse cycle packaged type dehumidifying unit, requiring only electric wiring to motors is available in sizes up to 5 hp. These units are marketed in Canada.

On the other hand, skating rinks that are designed for large seating capacity, i.e., hockey and public skating—usually have sufficient reheat available from spectators, or heated parts of the building, lights, etc., so that ventilation will disperse the fog and prevent condensation. Individual cases must be treated for prevailing local conditions, and dehumidification and ventilation requirements should be treated as an air conditioning problem.

VARIABLE DESIGN FACTORS

The variable factors which enter into the calculation of the actual refrigeration capacity for a skating rink are graphically illustrated in Fig. 10. This chart was prepared from a log run on an existing arena by use of recording thermometers.

Description of the Arena

Rink surface	80 × 180 ft = 14,400 sq ft
Floor concrete	4½ in. (1½ in. above piping)
Thickness of ice	1½ in.