THE CLAY DRAIN TILE INDUSTRY
IN SOUTHERN ONTARIO

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INTRODUCTION

History

The clay working industry is an ancient industry dating to unrecorded history. In England the first clay drain tile were used in 1804 and in the United States, by John Johnson, in 1835 at Geneva, N.Y. (12).

Irwin (7) states that clay drain tile were first manufactured at Bowmanville pottery, Canada West, in 1844. The first drain tile making machine was also imported to Bowmanville by Hon. S. Simpson in 1846. Irwin also states that these early drain tile were of a horseshoe shape and that round drain tile did not appear in Ontario until about 1875. Early drain tile were made in wood-fired open kilns and were generally of low quality. The production of drain tile was usually a family business operated as a sideline to farming during the summer months. By 1893 there were 193 drain tile plants in Ontario but only 51 in 1906 (2), 84 in 1929 (8) and 31 in 1968 (11).

The value of drain tile produced in Ontario in 1968 was 6.1 million dollars. The plants employed 650 people and paid over three million dollars in wages (4). It is a substantial industry.

Use

In this paper the authors are primarily concerned with clay drain tile as used in agriculture. This is not the only use. In 1967 about 700,000 feet (210,000 m) of drain tile of sizes larger than 4-inch (100 mm) were used for municipal outlet drainage purposes. Substantial amounts are used in green house beds for drainage. About 15 percent of the total production is used commercially for house footing drains and for septic tank beds. About two percent is exported. Drain tile is also used for drainage of urban areas such as sports fields and a small amount for decoration purposes. Other products manufactured by these plants are chimney flue lining and a small amount of face brick. The balance of the drain tile is used in agriculture for drainage of land.

RAW MATERIAL

Location

The raw material used for the manufacture of drain tile is shale or common surface clay. The principal shale areas where the industry is situated is the Thedford-Parkhill area of Hamilton Shale and the Queenston Shale which stretches from Niagara Falls to Owen Sound along the Niagara escarpment. Other small areas exist such as south east of Ottawa. The area near Ottawa and several at Toronto have been lost to urbanization.

The principal clay areas are scattered and small, generally, but not exclusively associated with stone free clay plains. Clay must be used where it is found; consequently the drain tile industry is widely scattered throughout rural Ontario.

Physical Characteristics

The mineralogical composition of the raw material is often an important factor in its performance. Clays containing lime pebbles present difficulties. If the pebbles are not finely ground, on firing the calcium carbonate forms calcium oxide which hydrates on exposure to air or moisture. The hydration expands the lump which ruptures the drain tile surface.

The presence of iron and low lime content in common clay and shale usually fire salmon or red. Brady and Dean (3) state that the presence of calcite and/or dolomite strongly affects the colour and properties of clays and shales. As the carbonate content increases, porosity increases, fired shrinkage and hardness decreases, and the fired colour changes from red to buff. Many clays, such as those in southwestern Ontario fire red but have other problems such as lime pebbles and drying difficulties.

Deposits having excellent drying and firing properties are scarce. Most clays are of the Pleistocene age and their composition reflects their bedrock source, that is, mostly limestone. Shales of the Hamilton and Queenston formations are of Devonian age and burn red.

Drain tile are made by the stiff mud process so the clay must have sufficient plasticity to extrude readily. If the clay is not plastic it will tear at the die and deform; again, if too plastic, it will not extrude.

PRODUCTION

Process

No two manufacturers follow the same production process because of the special needs of their plant. A typical stiff mud operational sequence using low grade common clay or plastic shale is given here but may not represent any one plant.

The clay pit is cleared of unwanted surface soil and other material with a bulldozer and then the clay is removed from the pit bank by front end loader or backhoe and loaded onto a truck. The pit is usually 500 feet (150 m) from the plant. The truck dumps the raw material in a stockpile. The stockpile may have a temporary cover to keep off rain. It may also be a permanent storage building if the plant operates all year, a practice followed by 65 percent of the plants.

A front-end loader takes the clay from the stock pile and dumps it into the sub-floor pug mill feeder. The clay is then carried by conveyor belt to differential conical rolls. These are smooth rolls, a small roll travelling at high speed and a large roll at low speed. The rolls crash and grind the raw material and remove larger stones.

The ground clay or shale is then fed to
a combined pub mill and extruder. Tempering water is added as required for the proper stiff plasticity. The drain tile are usually extruded through the die as a single stream at the rate of 1,600 to 2,000 feet (490 to 600 m) per hour under a vacuum of 15 to 20 inches (40 to 50 cm) of water. The dies establish the shape and size of the drain tile. Wear on the extruder dies affect the wall thickness of the drain tile.

The extruded column is cut to length by an automatic wire cutter and then stacked in three tiers on a rack or car. Lift trucks place the racks in a drying room. Waste heat recovered from the crown of the firing kilns enters the driers through floor slots. Drying time is about three days at a temperature of 130°F (55°C), or 7 to 10 days if open-shed driers are used. Some use periodic driers for week-ends. Temperature and humidity should be controlled but this is not usually the case in Ontario.

From the driers the ware is set in a kiln for firing. The kilns are mostly of the round down-draft type and ware is stacked about 13 tiers high. The temperature in the kiln is raised to about 1,800°F (985°C) and is held for 48 hours and then allowed to cool. Firing is by wood, coal, gas or bunker oil. Many kilns will have a 200°F (94°C) temperature difference between the floor and crown which results in a variation in quality. The kilns usually "turn over" on an eight-day cycle. The ware is unloaded from the kiln by conveyor belt and is then palletted or stacked in the storage yard. Over 60 percent of agricultural drain tile is shipped loose.

It is most difficult to balance a plant so the extruder capacity matches the drying and firing capacities. Most plants have a surplus capacity in some part of their operation.

Volume

The Ontario Department of Mines (10) reports drain tile production annually. Figure 1 shows production from 1940 to 1968. The rate of increase since 1945 has been rather uniform at 2.4 million feet (730,000 m) per year.

Table 1 shows the changes that have occurred in drain tile production plants. The consolidation and improvement of facilities, the reduction of plants, and the increased production marks the emergence of a technically-complex industry from a family industry. The six largest plants now produce over half the drain tile.

An analysis of drain tile sizes shows that 90 percent of the production is 4-inch. The percentage of other sizes are: 5 inch - 2, 6 inch - 4, 7 inch - 0.7, 8 inch - 1.6, and 10 inch to 14 inch - 1.3 percent.

Economics

Many manufactured products have a relationship between price and weight. Figure 2 shows the relationship between unit drain tile weight and unit price. For sizes over 8-inch (200 mm), the relationship rapidly spreads probably due to the labour problem with the handling of the larger sizes.

Figure 3 shows the annual price of drain tile per thousand (M) in Ontario since 1940. Also shown are two standard price indices, the Eastern Canada Index for Equipment and Material as reported in Agricultural Statistics for Ontario (9) and the Engineering News Record Index for Materials (360 components of the Building Cost Index) (5). The price of drain tile has tended to exceed the indices since 1961.

PRODUCT PERFORMANCE

Quality

Product quality has been a controversial issue for many years and yet, the produce from Ontario drain tile plants have proved to be quite acceptable in a century of service.

Rore (6) concluded from a series of tests that drain tile in Ontario were generally satisfactory as far as strength was concerned but most surface clay samples failed the test for absorption.

In 1969 a sample of 100 drain tile from a single kiln were loaded to failure. The average breaking strength for these

![Figure 1. Drain tile production, 1940-1968.](image1)

![Figure 2. Relationship of weight to price.](image2)
drain tile was 1,050 pounds per lineal foot (1,560 kg/m). The percentage distribution of strength may be seen in Figure 4. The distribution is skewed toward the higher strengths which may be due to a certain amount of culling of cracked drain tile at the plant. The A.S.T.M. (1) specification for clay drain tile permits 20 percent of the standard drain tile to be 15 percent below the average. In this sample all drain tile were within this criteria.

Summary of the Industry

(a) Clay tile production is increasing at about ten percent per year. The bulk of the increase is accounted for by producers using shale or shale-surface clay mixes. This production rate will continue as long as the operations can achieve an adequate return on investment. The owners and managers have been operating large scale brick and clay product businesses and will readily divert funds into other operations if the clay tile market weakens. One third of the established clay producers are not expanding and seven of these are barely maintaining their operations. Many of the plants will cease to function or be sold to more aggressive operators.

(b) The major factor limiting the growth of the clay tile industry is the return on investment. Poor returns are related to small scale of most operations, the inadequate business management of many owners, the low quality of labour and the general inefficiency resulting from this situation.

(c) Tile quality in general is acceptable. The Ontario Clay Tile Manufacturing Association has stated a policy of adoption of A.S.T.M. (1) standards. Through the efforts of the Association some improvement in the general philosophy and product of the industry may be expected.

REFERENCES