Welded Steel Pipe Design

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Welded Steel Pipe

During the 20th Century, advancements were made in steel pipe — in the economy of production and the quality of the product. Noteworthy are the machines and technology for cold-forming of flexible pipe from coils of sheet steel with automated spiral welds. Great strides were made in quality control, testing, joints and protective coatings. Welded steel pipe is available in wide ranges of sizes and properties of the steel. Included in this manual are the design criteria for steel pipe up to 240 inch (6,000 mm) in diameter under either internal or external pressure. The requirements of buried flexible pipe are: strength, ease of installation, high flow capacity, leak resistance, long service life, reliability and versatility, and economy. The properties of steel are well adapted to these seven requirements of buried pipelines. An explanation of each requirement is found in *Properties of Steel Pipe*, page 6.

Research and Development

STI/SPFA — comprised of two divisions, Steel Tank Institute and Steel Plate Fabricators Association — has served water, food, petroleum and chemical markets since 1916 as developers of standards and certification programs for quality, safety and reliability in the manufacture, installation and testing of steel tanks, piping and pressure vessels. Leading North American producers of steel pipe and pipe- protection materials collaborate with pre-eminent pipeline engineers as members of STI/SPFA. The association and its members sponsor research, and maintain facilities that perform research, on metallurgy, welding, joints, pipe linings and coatings. New product developments and improvements in manufacturing processes are frequently under study. In addition, representatives of STI/SPFA and their members serve on committees engaged in the preparation of national codes, standards and specifications for the design, installation and operation of steel tanks and pipelines.

The American Iron and Steel Institute (AISI) serves as the voice of the North American steel industry in the public policy arena and advances the case for steel in the market- place as the material of choice. AISI also plays a lead role in the development and application of new steels and steel- making technology. AISI's Market Development mission is to grow the competitive use of steel through a market-driven strategy that promotes cost-effective, steel-based solutions. The program focuses on the automotive, construction and container markets. AISI's member companies represent approximately 75% of both U.S. and North American steel capacity.

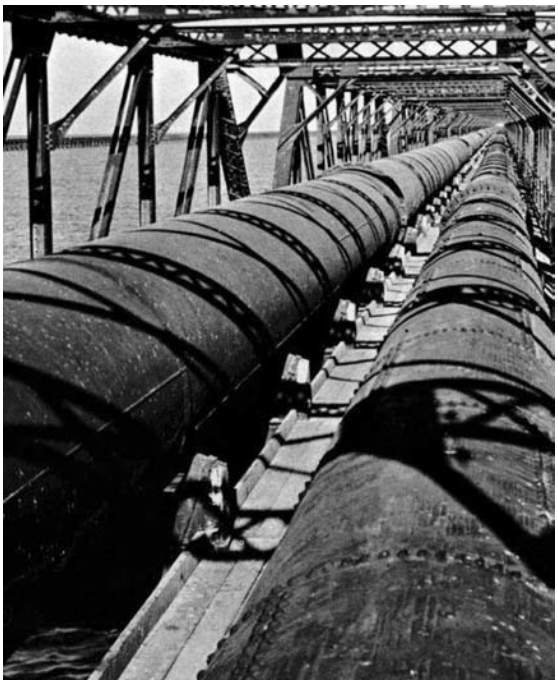
History of Steel Pipe

Pipes for water supply began to be used around 2500 B.C. The Chinese transported water through bamboo. In Southern Europe and the Near East, tile pipes were crafted to supply water for the baths of kings and emperors. The age of iron began about 1000 B.C. Classical historians don't spend their time investigating pipes; however, bits of information on pipe development have been recorded by engineers. One such document is *History of Steel Water Pipe* by Walter H. Cates, who spent his professional lifetime designing steel pipes with Consolidated Western Steel, a Division of U.S. Steel Corp. Parts of the following are abstracted from Walter Cates' document.

Search for Strength and Durability

Before the 19th Century, iron was used mostly for weapons: spears, swords, muskets and cannons. In England in 1824, James Russell invented a machine for welding iron tubes. In 1825, Cornelius Whitehouse invented a method for making pipe by drawing long, flat strips of hot iron through a bell-shaped die. These inventions opened the way for iron pipe. Iron pipe had much more strength and durability than pipes of tile or bamboo. After the Russell and Whitehouse inventions, interest in iron pipe soared. Major development occurred in four stages:

1. In 1830, the first furnace was built in the United States for making wrought iron pipe. Soon thereafter, more furnaces came into production.



City of San Francisco, California – Bay crossing of the Hetch Hetchy Aqueduct. 66 inches diameter, 3/8-inch and 1/2-inch steel plate.

In 1858, steel sheets, shipped to San Francisco for building needs, were rolled into pipe 11 inches to 22 inches in diameter and installed in Calaveras County, Calif. The pipe has been in use practically continuously since that time.

The demand was enormous because of the need for water distribution in fast-growing cities. Those wrought iron pipes were in small diameters and few sizes. Production was limited because iron was not available in large quantities.

2. The Age of Steel was born in 1855 in England, where Sir Henry Bessemer patented a process for production of steel. Development of the open-hearth furnace in 1861 made inexpensive steel available in large quantities — thousands of tons. Before then, steel had been available only by the pound. Steel made it possible to cold form sheets into pipes of any diameter. Soon after the 1849 gold rush in California, English sheet steel was formed into tubes with longitudinal riveted seams. One end of each pipe "stick" was crimped so it could be stabbed into the next stick like stove pipes. Sections were joined by simply hammering them together. From 1860 to 1900, virtually all water pipe was cold formed from steel sheets and riveted. More than 2 million feet were installed during that period.

3. The third major development was Lock-Bar steel pipe in 30-foot lengths. It was first fabricated in 1905 in New York. Two semi-circular pipe halves were joined by inserting the edges of each into two longitudinal lock-bars with an H-shaped cross section. The edges of the pipe halves were planed and up-set to a slightly greater thickness to form a shoulder for engaging the lock-bar. The lock-bar was then closed under 350 tons per foot of length. The pipe edges were clamped in the lock-bar. The seam was 100% efficient. Some single riveted seams were only 45% efficient, and double riveted seams only 70% efficient. The interior of this new pipe was smoother than riveted pipe. Carrying capability was increased by 15% to 20%, according to the manufacturer. Lock-Bar made inroads into the steel pipe market. Data from 1915 to 1930 indicate 3.3 million feet of Lock-Bar was installed vs. 1.5 million feet of riveted pipe.

4. The fourth major development was automatic electric welding. Electric welding started as a novelty in 1920, but made great progress during the 1930s, when welding machines and fluxes were developed. From 1920 to 1940, approximately 7 million feet of welded steel pipe were installed. During World War II, virtually all steel production was diverted into military equipment, arms and armament. Navy ships were welded to shorten the time of construction. Welding technology improved. After the war, the latter half of the 1940s, pro- duction began of welded steel pipe by straight seam electrical resistance and fusion welding. Spiral fusion welding was just coming on line. The 1950s began an era of longer and larger pipelines.

Purchase this course to see the remainder of the technical materials.