THE PAST, THE PRESENT AND THE FUTURE OF POLYETHYLENE MANHOLES FOR WATER DISPOSAL SYSTEMS

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History

The use of manholes started with the development of water disposal systems. External underground sewage networks have always had accessible points for inspection and cleaning. These access points were often made of the same materials as the sewer pipes – clay, stone, bricks and concrete. Many old cities still have sewer systems largely composed of brick, ceramic and concrete pipes today.

Over time, the technological improvements in the production of construction materials allowed the mass production of pipes, which led to a reduction in cost and an improvement in the quality of products. Concrete pipe plants began production of parts for manholes, as the in-situ concrete moulding process was more labour-intensive and resulted in poorer quality structures. Concrete manholes, as we know them today, have been in use since the nineteenth century.

In addition to pipes made from conventional materials, the start of the 1930s saw mass production of plastic pipes, made initially of PVC, and then of polyolefins, such as PE and PP. Plastic pipes had a significant advantage over concrete: because they are not susceptible to corrosion they can have a significantly longer operating life. In addition, the greater integrity of their joints protects against leakage and the infiltration of ground waters into the water disposal system.

From the second half of the last century, water disposal systems were split into domestic and storm water disposal systems to ensure better and more cost-effective treatment of municipal sewers. The corrosion rate of concrete in the domestic sewers had significantly grown due to high concentrations of methane. This could be one of the main reasons for the rapid rise in production of plastic pipes for external gravity sewers. By comparison, the plastic fittings and manholes market evolved relatively slowly. It required large investments in moulds, plastic materials, and a vast diversity of products, whereas concrete required fewer costs and allowed in-situ moulding. As a result, modern external sewer systems are usually made of two materials – plastic pipes and concrete manholes. Such a combination remains controversial, as the technical advantages of plastic pipes are undermined at the point of connection with the concrete manholes.

Development of plastic manholes

Europe was traditionally a trend setter for the application of plastic pipes in sewers. Scandinavia was most open to innovations with the highest number of plastic pipelines in the world, compared with other materials (concrete, cast-iron etc.). So it is no wonder that the development of plastic manholes for sewers started in Scandinavia. The technological progress in sewer networks maintenance was one of the major factors of this development, e.g. hydraulic machines for high pressure jetting, and CCTV

Pic. 1. PE560 UPONOR Inspection Chamber

Pic. 2. K400 Mabo Inspection chamber

inspection of the pipelines. These new technologies made pipeline servicing from the ground possible via small manholes. Plastic manholes could compete with the concrete versions, providing low cost maintenance and extended operating life. In the 1980s, Uponor started production of PE manholes with chambers made of smooth pipe with diameters of 560 and 800 mm, and trays welded using manual extruder, base and pipes for connection to the pipelines (pic. 1). This design is still used in Finland today.

The development of modern manhole systems started in the 1990s when Norwegian Mabo started production of the first moulded bases for inspection chambers, OD/DN 400 mm (pic. 2). The initiative was taken by Dutch Wavin Nordic, and then similar production kicked off in other developed countries of Western Europe: Germany, Holland and Great Britain. In 2000, the 400 mm inspection chambers market in Germany hit over 100,000 units per year. The application scale of inspection chambers depends on the approach of the operating companies, e.g. 400 mm inspection chambers are widely used for city networks up to DN 400 mm in Scandinavia, Baltic states and Poland. Germany, France and Great Britain allow application only within certain areas and in private residences and cottage estates, with diameters up to 200 mm.

Modern PE manholes systems

The second stage of plastic manhole development started in the 2000s. Israeli Hofit and Romold started using rotational moulding technologies. They tried to create an alternative to concrete manholes, with shaft diameters of 800 and 1000 mm, to achieve mass application of plastic manholes in mains networks in the previously mentioned “conservative” countries (pic. 3). Rotational moulding technology has a number of advantages, including the relatively low cost of moulds. So the price of the first modular

1000 mm manholes was quite competitive when compared with their concrete counterparts. Unfortunately, the quality, especially with regard to static load resistance and integrity, did not meet the expectations for mass application in developed Western European countries. As a result, we have mainly seen a rise of rotational moulding manhole applications in Eastern and Southern Europe.

Holland's Wavin has invested heavily in moulds and equipment for low pressure moulding, trying to eliminate the disadvantages. The Tegra 1000 modular manhole (pic. 4) proved much better than rotationally moulded analogues. However, the connection sizes were no greater than OD/DN 315 mm. The limited range of the manhole base configurations, together with the problems of additional manual extruder welding, didn't help to promote mass application of the new product.

Pipelife, Kaczmarek, Rehau followed Wavin and tried to create their 1000 mm manholes using various low pressure moulding technologies (pic. 5). Low pressure moulding uses low cost aluminium moulds, creating a manhole with a light inner layer, and reducing consumption of raw materials. The downside of this technology is the need to weld extra connections which can compromise integrity due to the different yield points of the materials. All attempts to create an ideal 1000 mm manhole led to limited manhole base designs and a small range of connections, mainly up to OD/DN 315 mm, with quality and robust welding of extra connections proving challenging (especially for diameters above OD/DN 400 mm).

The main alternative for moulded modular manholes was a welded manhole made of pipes with a structured wall (two-layer corrugated or spiral-wound walls). A manual extruder is used to produce such manholes. The technology is very labour-intensive, and in many cases, does not guarantee good quality compliance, static load resistance and long-term integrity.

Regulation

Plastic manhole applications in Europe are regulated by EN 13598-2, Plastics piping systems for non-pressure underground drainage and sewerage. Unplasticised poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE). Part 2. Specifications for manholes and inspection chambers in traffic areas and deep underground installations.

It should be noted that European regulation was created together with leading manufacturers of plastic manholes at the beginning of the 2000s and has a number of compromises, e.g. in deformation resistance of the manholes with an outer load in places with high levels of underground waters etc. These compromises allowed the use of manholes made by all major producers, with some limitations.

In Russia, from 1 July 2015, a new GOST 32972-2014 Plastic manholes for sewerage came into force, which is essentially an adaptation of EN 13598-2. There is substantial work being done on updating construction regulations to enable wide use of plastic manholes in the construction of drainage network systems.

Conclusion

In summarising this brief review on development of plastic manholes market it should be highlighted that:

– plastic inspection chambers have replaced concrete ones in the niche market;

– plastic manholes with diameter over 800 mm (mainly 1000 mm) still make a small share of the market due to their price, and top quality manholes don't always justify the price;

– rotationally moulded 1000 mm manholes don't meet all the requirements of GOST or EN or meet the requirements with some exception;

– welded 1000 mm manholes don't always meet GOST or EN requirements due to high dependance of human factor;

– moulded 1000 mm manholes have standard solutions with only small diameters of connections (up to OD/DN 315 mm) and limited range of base designs;

– Russian market, apart from inspection chambers, needs 1000 mm and over plastic manholes with unlimited range of manhole base designs;

– Russian market needs plastic manholes with connections up to DN 1000 and solutions for servicing of up to 3000 mm.

Pic. 3. 1000 mm rotational moulded manhole

Pic. 4. Tegra 1000 mm Wavin manhole

Pic. 5. 1000 mm Pipelife manhole