EduVision: Journal of Innovations in Pedagogy and Educational Advancements
Volume 2, Issue 6, June 2026
brightmindpublishing.com
ISSN (E): 3061-6972

USING RECYCLED PLASTIC COVERS FOR SEWER TANKS

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Abstract
The article analyzes the technical, economic and environmental advantages of covers made of recycled plastic materials for sewage and communication wells. Compared with traditional cast iron covers, the corrosion resistance, lightness, long service life and the ability to reuse secondary raw materials of recycled plastic covers are considered. The importance of these products in urban infrastructure and environmental protection is also scientifically highlighted.

Keywords: Recycled plastic, sewer manholes, cover, ecology, waste recycling, infrastructure, polymer composites.

Introduction

As a result of population growth and accelerated urbanization processes, the demand for elements of municipal infrastructure is increasing. Covers for sewer manholes and engineering communications are an important component of urban infrastructure. Traditionally, such covers are made of cast iron or concrete. However, they are heavy, prone to corrosion, and are subject to theft as metal.

Cast iron manhole covers have been widely used for many years due to their strength and high load-bearing capacity. However, in practice, a number of negative situations are observed, such as breakage of these covers under the influence of heavy transport loads, corrosion, and theft. These problems are not only economic losses, but also pose a threat to human life. One of the main disadvantages of cast iron manhole covers is their fragility.

Research methodology

Although cast iron material withstands compressive forces well, it is prone to brittle fracture under impact and repetitive dynamic loads. Especially on highways,

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microcracks appear in the covers as a result of the movement of heavy trucks, buses and special equipment. These microcracks enlarge over time and lead to sudden breakage of the cover. As a result, a dangerous open depression is formed in the road surface. This can cause damage to vehicles, accidents and injuries to pedestrians (Figure 1).

Figure 1. A cast iron sewer cover broken as a result of external impact.

Mechanical defects that occur in sewer covers under heavy loads are listed in Table 1 below:

Table 1

Mechanical defects in cast iron covers for sewer pits under heavy loads	
1	Increase in elastic deformation
2	Wear of supporting surfaces
3	Metal fatigue
4	Brittle fracture due to impact loads
5	Slippage between the cover and the frame

In areas with high traffic flows, repeated exposure to loads accelerates the process of metal fatigue. As a result of metal fatigue, dislocations and microcracks form in the internal crystal lattice of the cast iron. This reduces the mechanical strength of the cover [1].

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Another important problem is the corrosion process. The sewage system contains moisture, aggressive gases (methane, hydrogen sulfide, carbon dioxide) and a chemically active environment [2]. These factors lead to oxidation of the cast iron surface. As a result of corrosion, the metal thickness decreases, surface roughness increases and mechanical strength decreases. Freeze-thaw cycles, especially in winter, accelerate the corrosion and cracking processes.

One of the most pressing problems of cast iron covers is their theft. Since cast iron contains valuable metals, in some cases the covers are stolen for illegal disposal as scrap metal. Open sewer manholes pose a serious man-made hazard. It is especially difficult to notice such open pits at night or in rainy weather. As a result, pedestrians fall, children are injured, or cars fall into pits. The economic consequences of theft are also significant. Because the cost of producing a new cover increases, additional funds are required for repair and installation work, road safety decreases, and the operating costs of public utilities increase.

It is known that polymer waste decomposes very slowly in nature and pollutes the environment for a long time. The use of these wastes as secondary raw materials in the production of manhole covers reduces the volume of waste, reduces the load on landfills, and ensures environmental sustainability. This is in line with the principles of the “green econom”. In recent years, as a result of the development of waste recycling technologies, the production of manhole covers from recycled plastic materials has become widespread. This method not only reduces environmental problems, but also provides economic efficiency.

Recycled plastic caps are mainly made from polyethylene (PE), polypropylene (PP) and other thermoplastic polymer waste [3].

The production process steps are listed in Table 2 below:

Table 2

Production process stages	
1	Plastic waste collection and sorting
2	Washing and grinding
3	Granulation
4	Preparation of polymer composite mixtures
5	High-pressure pressing or molding

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In many cases, glass fibers, mineral fillers, or other composite additives are used to increase the mechanical strength of the product. Recycled plastic caps have important technical advantages such as corrosion resistance, light weight, dielectric properties, and anti-theft protection.

Plastic composite materials have high resistance to chemicals and last a long time. The mass of plastic covers can be up to 40-70% less than their cast-iron counterparts [4]. This significantly reduces transportation and installation costs. Plastic materials do not conduct electricity. Therefore, they are considered safe for wells where electrical and telecommunication networks are located. Recycled plastic covers do not have a high value as secondary raw materials, since they do not contain metal. As a result, the incidence of their theft is sharply reduced.

Results and discussion

Millions of tons of plastic waste are generated worldwide every year, much of which ends up in landfills, negatively impacting soil and water resources.

The environmental outcomes resulting from the production of manhole covers from recycled plastic waste are presented in Table 3 below:

Table 3

Effective results of producing sewer covers from plastic waste	
1	Reduces the amount of waste sent to landfills
2	Reduces the use of natural resources
3	Reduces greenhouse gas emissions
4	Develops the principles of a circular economy

Recycled plastic products are an important tool in achieving sustainable development goals.

Figure 2. Recycled plastic sewer cover.

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The use of secondary raw materials in the production of recycled plastic caps reduces the cost of the product. In addition, transportation costs are reduced, installation work is simplified, the repair and replacement period is extended, and losses associated with theft are reduced. These factors bring significant economic benefits to utility companies.

Recycled plastic caps also have some disadvantages. In particular, they can be deformed at high temperatures and have reduced mechanical properties under very high dynamic loads. Therefore, modern research is aimed at improving the composition of composite materials, increasing the proportion of reinforcing fibers, and ensuring that products comply with standards. In modern practice, there is a growing trend to use polymer-sand, composite or reinforced plastic covers instead of cast iron covers. These materials are corrosion-resistant, lightweight and have no metal value, so the risk of theft is much lower. In addition, modern composite covers are also important in that they can withstand high mechanical loads.

In the future, the development of polymer composite technologies will allow further improvement of the mechanical and operational properties of these products.

The development of recycled sewer covers based on plastic waste is one of the most promising areas today in terms of environmental, economic and technological aspects. Covers made of recycled polymer materials have a number of significant advantages over traditional cast iron covers, which are of great importance in the development of modern municipal infrastructure. Along with lightweight construction, modern polymer-composite materials can also have high mechanical strength. When special reinforcing additives (glass fiber, basalt fiber or mineral fillers) are added, the compressive and bending strength of the covers increases. Therefore, they can be effectively used on highways and pedestrian areas. Covers made from recycled plastic materials can be manufactured in various shapes and designs. During the production process, company logos, technical markings or safety elements can be molded. This improves the functional and aesthetic properties of the product. The production of caps based on recycled plastic is also economically beneficial, as the cost of secondary raw materials is lower, energy consumption is lower than that of cast iron smelting, carbon dioxide emissions are reduced during the production process, and new jobs are created through the processing of local waste.

Conclusion. The use of recycled plastic covers for sewer pits is an environmentally, technically and economically effective solution. Plastic covers are much lighter than

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cast iron covers. This reduces transportation costs, facilitates assembly and disassembly, reduces labor costs and simplifies maintenance. They are corrosion-resistant, lightweight, safe and have a long service life. Most importantly, recycling plastic waste reduces the negative impact on the environment. Therefore, expanding the use of recycled plastic covers in municipal infrastructure facilities is one of the important directions of sustainable development.

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