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CONCEPT OF LOADING-UNLOADING WORK AT LARGE LANDFILLS BY MEANS OF TRANSPORT MECHANIZATION

Milomir GAŠIĆ

Faculty of Mechanical and Civil Engineering in Kraljevo, University of Kragujevac, Serbia

Abstract

Disposal of municipal waste at the large landfills having interregional importance, with short stay of transport road vehicles, can be successfully performed by means of transport mechanization. The storage bunker is introduced in the unloading system of transport road vehicles and it is discharged by some means of transport (screw transporter, scraper transporter, etc.) whereas the bucket is loaded with waste.

The paper suggests the concept of transport of loaded and empty buckets by means of steel ropes, which diminishes the number of machines for waste spreading as well as the number of workers. Also, the transport road vehicles cannot access the landfill area and thus cannot be stuck there, especially in cases of heavy atmospheric precipitation. The length of bucket transport depends on the landfill width which is up to 300 m. If the concept includes the linear motion of steel ropes columns, the landfill length being a limiting parameter will be totally eliminated.

Key words*: loading-unloading work, landfill, transport mechanization, steel ropes, column.*

1 INTRODUCTION

Unlike a large number of European countries where methods and technologies for waste disposal were successfully developed, our country has many unregulated landfills (so called 'wild landfills') of municipal waste and other types of waste. It is found out that these landfills serve for disposal of harmful industrial waste which has specific characteristics such as:

- explosiveness, inflammability, carcinogenicity;
- toxicity caused by petroleum and petroleum products, color and lacquer leftovers in the form of residue, pesticides for weed eradication;
- remains of different chemicals.

Having this in mind, it is obvious that landfills have an important role in improvement of environment protection.

Disposal of municipal waste is often done at unregulated and unprepared grounds, which has a negative effect on the population as well as on water, land and air pollution. It should be noted that collection, transportation and disposal of waste are done by municipal companies which, as a rule, use old mechanization and generally do not make selective classification of waste (there is no waste recycling).

To eliminate above stated negative effects it is necessary to perform the following activities:

- classification (sorting) of waste must be done before waste disposal,
- several municipalities should be involved in the project of sanitary landfills (formation of large landfills), with the application of good solutions and experience of Western European countries,
- protection of water springs, river flows, soil and air,
- by-products (landfill gas) should be converted into electrical energy,
- population should be regularly educated on the importance and role of landfills.

When designing sanitary landfills, it is necessary to have data about the quantities of materials to be disposed. These quantities of materials depend on:

- the number of people living on the area where waste is collected and transported,
- characteristics of the area being analyzed,
- average daily amount of municipal waste per citizen,
- the level of awareness of the significance of collecting and recycling the waste.

Regional sanitary landfills, as a justifiable solution, are becoming prominent in comparison to urban landfills, because they solve the problem of waste disposal over the long term.

It is clear that the project of regional landfill is a complex infrastructural facility which requires many influential parameters to be solved:

- location of the landfill,
- type and amount of waste materials,
- properties of waste materials,
- availability of the area meant for landfill planning,
- geotechnical and urban preconditions which are needed to make the landfill profile (characteristics and properties of the land beneath the landfill, isolation of permeability of waste into the land beneath the landfill, use of landfill gas, landfill closure)
- later use of the area where the landfill is built,
- legal regulations and accompanying rules.

The landfill location should provide total sanitary and epidemiological safety of the local population and workers, as well as the protection against land, water and air pollution.

Thus, the following locations are usually used to make landfills:

- coves sheltered by steep sides of cliffs,
- natural deep valleys,
- deep valleys made by extraction of ore or building materials,

where the newly formed area should fit into the surrounding terrain after landfill is made.

Apart from these conditions, selection of the landfill location should not threaten the minimum distance from settlements, roads, railways, water lines and the like. In addition to these limitations, it is necessary to make an analysis of influences of wind direction and speed, closeness of inert materials used for waste covering, traffic connections with settlements, closeness of electrical power network, and supply of water used for technical purposes.

2 LOADING AND UNLOADING WORK AT LARGE LANDFILLS

As stated above, transportation of waste materials to urban landfills is mostly done by special trucks for waste transport. Waste is unloaded from the truck, and then spread by bulldozers having loading shovel and compressed by compactors. Finally, it is covered by a layer of inert materials (Fig. 1).

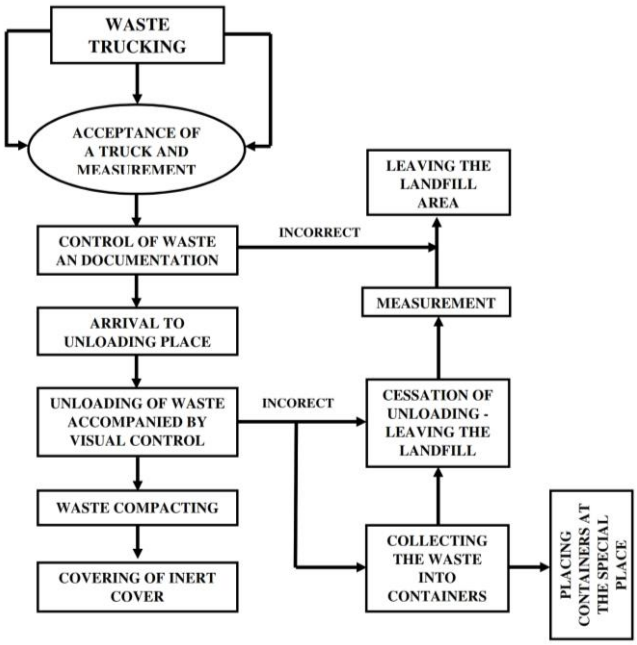

Fig. 1 *Diagram of technology for waste disposal at urban landfills*

As far as large (regional) landfills are concerned, this type of waste disposal is not applicable primarily due to enormous amounts of waste materials being transported. The cross section of a typical city landfill whose width is up to hundred meters, shown in Figure 2, enables disposal of waste materials of large volumes (up to a half million cubic meter m^3).

It is hard and sometimes almost impossible to unload waste materials from trucks at the very area of the landfill, because the terrain itself does not provide conditions for adequate mobility, which directly influences the decrease of transportation capacity and increase of costs.

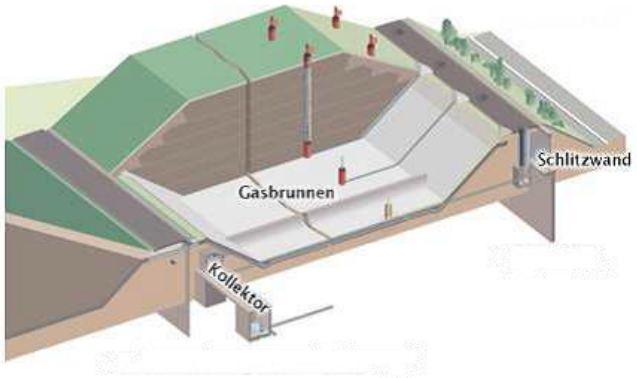

Fig. 2 *Cross section of a typical city landfill*

3 LOADING AND UNLOADING WORK AT LARGE LANDFILLS

The concept of loading and unloading work by means of transport mechanization is a solution which can meet the requirements of efficient and economical disposal of large quantities of waste (Fig. 1). Elements shown on the Fig.3 are:

1. column
2. steel ropes
3. bucket
4. inclined transporter
5. bunker
6. transport vehicl

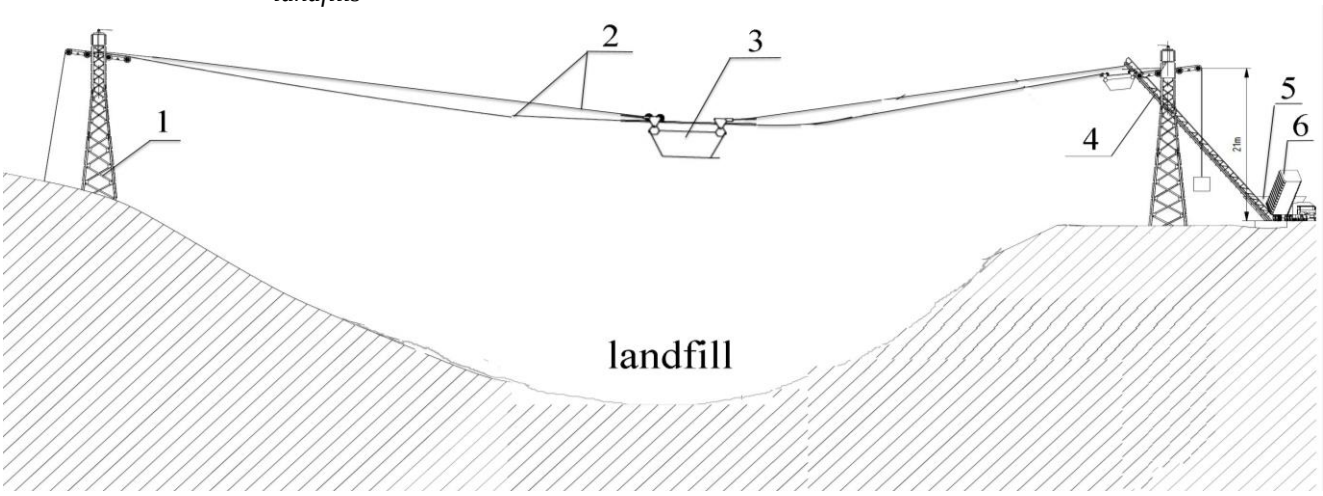

Fig. 3 Outline of transport mechanization used for waste unloading, transportation and disposal

The concept involves functional connection between the means of transport mechanization presented in Figure 4
The loaded bucket 4 (Fig. 5) is moved through steel ropes 1 which are tied to the columns 2 and 11. The columns provide transport movement thus eliminating the length of landfill as a limiting parameter.
The rope 3 used for lifting (lowering) the loaded bucket is placed over pulley/wheel 5 of the tackle head and over pulley/wheel 6 at trolley 7. It is tied to the column 2 at one end, while at the other end it is directed to drum of the lifting mechanism 8. To keep the jaws of bucket 4 at closed position when lowering and lifting, the number of rotations of drum 9 is synchronized with the number of rotations of lifting drum 8.
When loaded bucket is lowered to the level of unloading, drum 8 is fixed and drum 9 keeps rotating while rope 10 unwinds which makes the bucket jaws open and the bucket unload. After unloading, the bucket jaws are closed, lifted and moved to loading position at the column 11 by winding the towrope 12 round the drum 13.
From storage bunker containing waste being unloaded from trucks, worm transporters or some other types of transporters (such as scraper transporter) fill the bucket which is moved along the steel ropes to the loading position.
Basic parameters of the presented concept are:

- length of transporting path of the bucket: from 50m to 500m,
- bucket capacity: from 1t to 15t,
- column height: 5m to 50m,

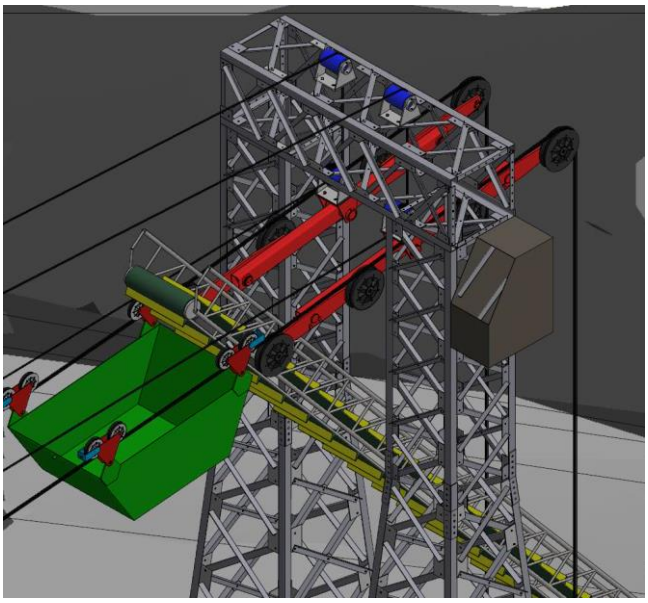

Fig. 6 *Column on the right side*

- speed of bucket lifting: 1m/s to 6.3m/s,
- speed of bucket movement: 1m/s to 0.3m/s,
- average time of bucket transportation cycle (depending on landfill width): ~ 120s to 180s,
- average time of bucket loading (depending on column height): ~ 90s÷120s.

Some of schematic subassemblies are presented on next figures.

Fig. 4 Block diagram of movement, lowering and unloading the bucket

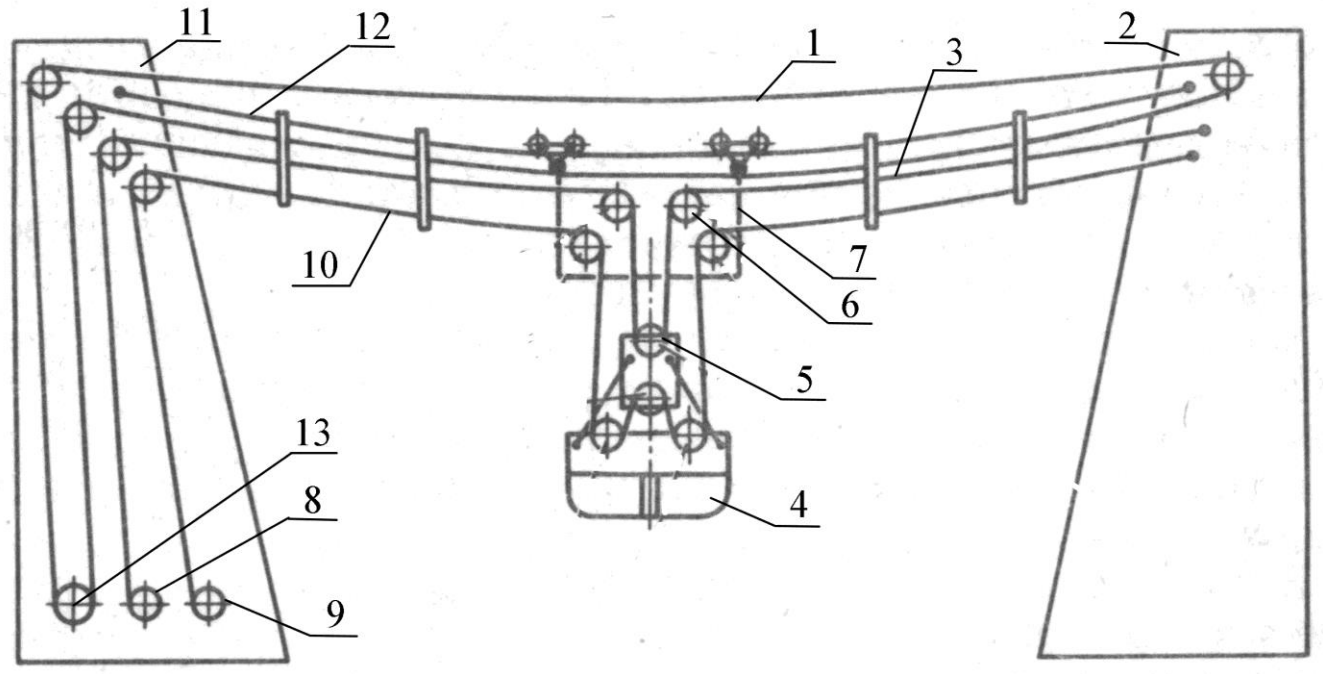

Fig. 5 *Technological outline of functional connection between means of transport mechanization*

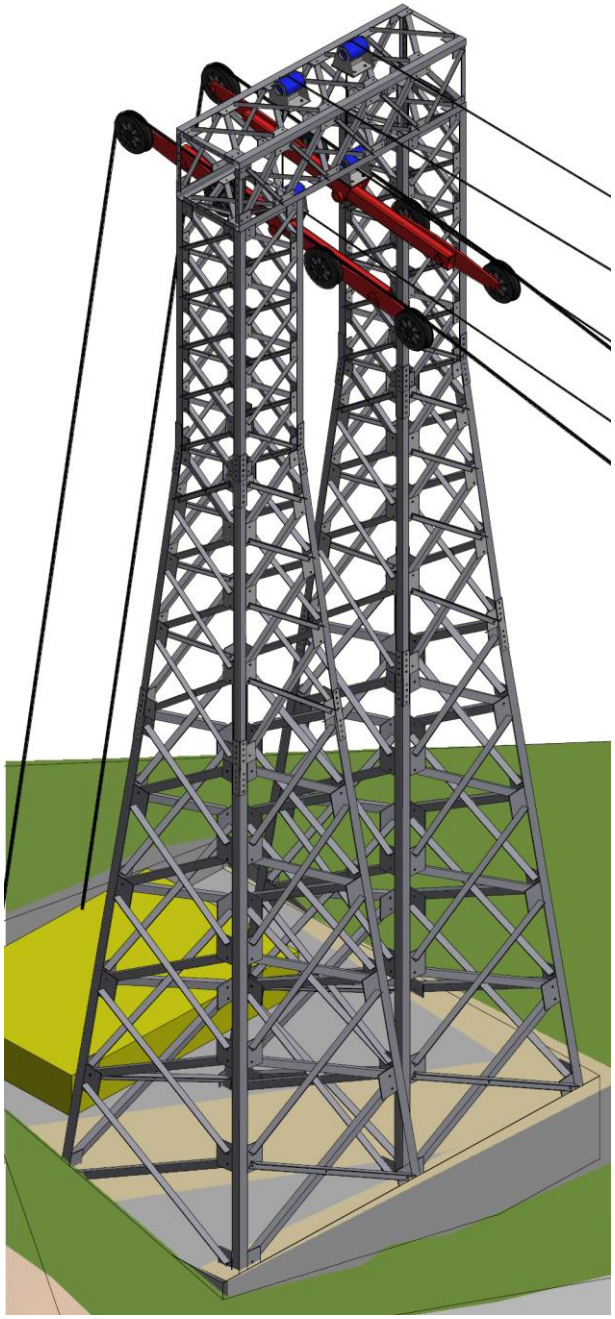

Fig. 7 *Column on the left side*

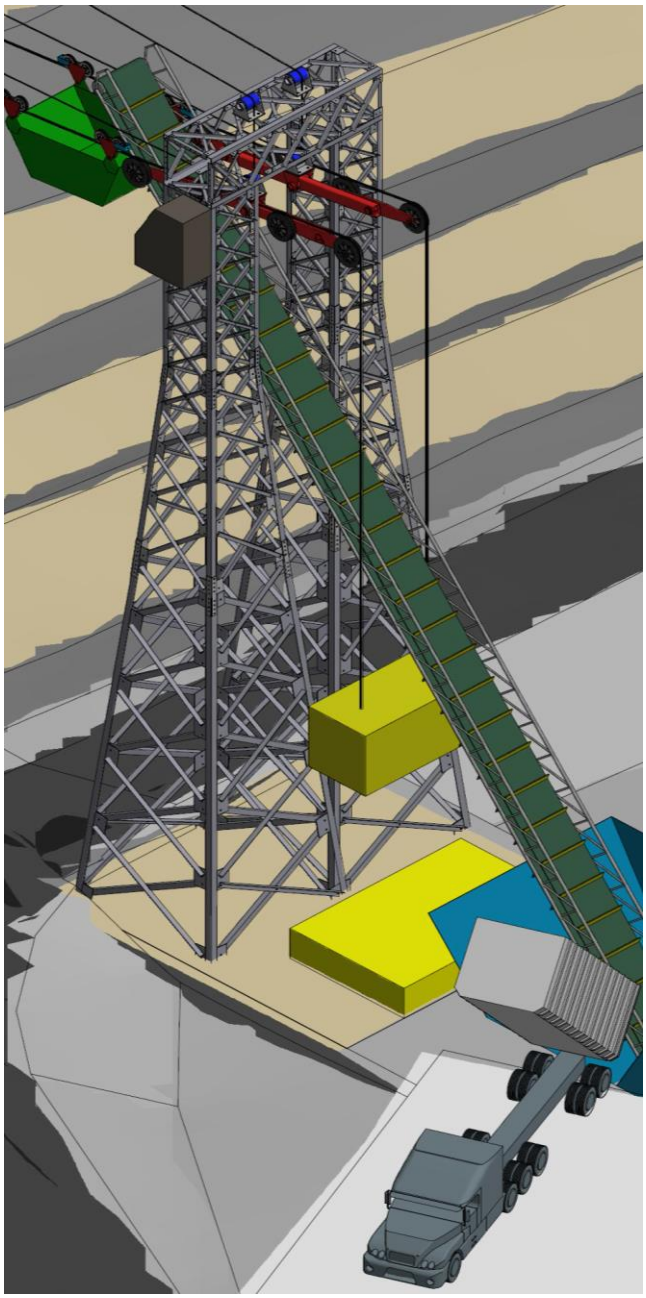

Fig. 8 *Bucket at loading position*

4 CONCLUSION

Application of means of transport mechanization is an optimal concept of unloading and loading work at large landfills because:

- costs of transportation within the very area of the landfill are diminished,
- transportation trucks cannot be stuck in the area of the landfill,
- a large capacity of waste disposal can be achieved,
- dimensions of the landfill are not limiting parameters (length x width) for unloading and loading activities,
- after the landfill is closed, the means of transportation mechanization can be moved to a new location.

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Contact address:
Milomir Gašić
Faculty of Mechanical and Civil Engineering in Kraljevo
36000 KRALJEVO, Dositejeva 19
E-mail: gasic.m@mfkv.kg.ac.rs