BUDOWNICTWO
CZASOPISMO TECHNICZNE
TECHNICAL TRANSACTIONS
CIVIL ENGINEERING
WYDAWNICTWO POLITECHNIKI KRAKOWSKIEJ
1-B/2010
ZESZYT 2
ROK 107
ISSUE 2
YEAR 107

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OPTIMAL RADIUS OF CENTRE INTEREST AREA FOR RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE

OPTYMALNY ZASIĘG CENTRALNEGO OBSZARU ZAINTERESOWANIA DLA UTYLIZACJI ODPADÓW BUDOWLANYCH I POCHODZĄCYCH Z ROZBIÓRKI

Abstract

Construction and demolition waste (CDW) presents a quarter of total originated waste amount in the EU. It follows that the treatment and another reusing of CDW is a current subject within waste management not only in Slovakia, but also in other states of EU. The significant role belongs to a location of waste origin and location of waste treatment place at recycling of construction waste. The basic systems of CDW recycling and their environmental impact at surroundings area of recycling place are analyzed in the submitted paper. There is proposed a suitable way of CDW treatment and interest area estimate method of existed recycling plants following this analysis, location of sources, markets and economic parameters of recycling costs. The expression of attribute is based on the knowledge of distribution logistic, which is able to describe whole distribution system of CDW recycling, elements and their interaction, which are necessary for calculation of interest area. This expression of interest area provide an effective utilization of existed power, estimate of requires on increasing power, eventually modernization of recycling plants and building of recycling centre in uncovered areas.

Keywords: recycling, construction and demolition waste, CDW, distribution system

Streszczenie

Odpady budowlane i pochodzące z rozbiórki (CDW)stanowią jedną czwartą wszystkich odpadów w UE. Zatem utylizacja i ponowne zastosowanie takich odpadów jest aktualnym tematem w ramach zarządzania odpadami nie tylko na Słowacji, ale także w innych państwach UE. Istotną rolę w utylizacji odpadów budowlanych odgrywa lokalizacja źródła pochodzenia odpadów i lokalizacja miejsca utylizacji. Artykuł analizuje podstawowe systemy utylizacji odpadów budowlanych i pochodzących z rozbiórki oraz ich środowiskowy wpływ na obszar otaczający miejsce utylizacji. Proponuje się właściwy sposób uzdatniania odpadów budowlanych i pochodzących z rozbiórki oraz metodę szacowania obszaru zainteresowania istniejących zakładów utylizacji w oparciu o tę analizę, lokalizacje źródeł, rynki oraz parametry ekonomiczne kosztów utylizacji. Określenie atrybutu opiera się na znajomości logistyki dystrybucji, która pozwala opisać cały system utylizacji odpadów budowlanych i pochodzących z rozbiórki, a także elementy konieczne do oszacowania obszaru zainteresowania wraz z ich wzajemnym oddziaływaniem.

Słowa kluczowe: utylizacja, odpady budowlane i pochodzące z rozbiórki, CDW, system dystrybucji

Odpowiedzialność za poprawność językową artykułu ponoszą autorzy

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1. Introduction

Construction and demolition waste present a quarter of total originated waste amount in the EU. It follows that the treatment and another reusing of CDW is a current subject within waste management not only in Slovakia, but also in other states of EU. We are the witness of serious differences in approaches of construction and demolition waste recycling in the many countries of European Union. The major requirement is the separating, disposal eventually the recycling of construction waste. The emphasis is on:

- maximization of disposal waste measure, mainly by waste reusing and in-site waste recycling,
- the increasing of recycling measure with the aim to make the products with higher added value,
- minimization of total costs, which are needed on unit of recycled material production.

2. System of construction and demolition waste recycling

The number of factors is necessary to regard during the solving of recycling system. The first factor is a location of waste origin and location of waste treating place.

According their location we know two main types of construction waste recycling technology:

- in-site recycling – in the place of waste origin,
- off site recycling – off the place of waste origin, in the recycling plant.

The recycling, which uses a partial stock-pile, presents third recycling way. It is some combination of the two main ways. There are created the waste stocks, where are transported construction waste and mobile recycling links. This recycling way is not used in Slovakia; therefore we do not apply it in followed part.

Which system will be dominated in particular region is depending on fact, whether the recycling plant is exist in the interested area or not [1].

In the present, the in-site recycling is according the survey result the most frequently construction and demolition waste disposal way. The mobile recycling links are used in place of origination waste. These recycling links treat the waste regardless of own impact on surrounding area. This state can be characterized as a control inconsistence abuse of legislative observance. In many cases, the recycling is provided in build-up areas near by settlement units, schools and hospitals. This presented example is unfavourable in future. According the obtained knowledge, the recycling conditions, which allow the immediate using of recycling machines in the place of expected waste origination, are existed rarely.

The effective using of this recycling way is only then, when a serious amount of suitable homogeneous waste for recycling plant utilization is in place of waste origination. There are used a mobile recycling links of suitable power. Their advantage is their mobility and the necessity of small area, simplicity and unpretentiousness of service, lower first costs and good variability of outputs parameters. The flexibility of these links allows the treating of relatively low amount of waste effectively and on the place of their origin. Their disadvantage is a lower quality of recycled material, which is caused of machines line-ups limits and their high price per unit of link power. What is more, the recycling by mobile link allows only basic waste treating, what is limited for other utilization.

The case of off-site recycling is the localization of high-capacity plant in studied region. This plant allows a complex treating and separation of waste and at the same time is possible to economic use the existing capacity and allows the treating of various waste sorts. The assumption of gradual transition to recycling on waste collecting place, results from research of actual stage of particular issue. It follows that is necessary to prefer the-site recycling in term of its environmental impact at surrounding area. This recycling is situated off built areas; its impact on surrounding (noisiness, dustiness, vibrations) is minimal.

2. Model of construction and demolition off-site recycling and its elements

The finding of optimal radius **„*R*“** for recycling plant interest area is necessary at appraisal of area covering requirement by recycling units and building-up of the recycling centres. This radius is defined in dependence on number of waste, its location, market abilities and transportation distances. The aim of definition is control of existing effective capacity utilization, the setting of requirements for increasing power, eventually for recycling plants modernization and the building-up of recycling plants in the uncovered places.

The complete distribution system of CDW recycling, elements and their interaction is necessary to expression for proposal of recycling centre optimal radius calculation. This proposal is based on knowledge of distribution logistic.

The system of CDW recycling is characterized by:
- own location,
- elements,
- links among elements.

The location of this system is dependent on more factors, where are belonged:
- economic stabile and strong locality,
- sufficient source (waste) volume,
- transportation distances and consequently their transportation costs,
- optimal machine line-up, [2]
- environmental criteria completion.

These effects are implemented into the specifications and the radius of recycling plant interest area is defined by those specifications.

The system is created by elements, which have a geometrical configuration and they are able to form a distribution network by mutual links. Therefore, we can talk about a topology of distribution network, which will define the main form of its and define the distribution sources. The knowledge about source localization is necessary to know during the solving of this network. On the second hand, we have to use the criteria such are – the location and the access, maximal time, length of trajectory, priority of roads, the capacity of vehicles and their numbers, price, flexibility of supply etc. A methods of mathematical-economical modelling is able to use for solving of this problem [3]. There is needed to quantify the interaction among particular elements of system for the using the methods of mathematical-economical modelling.

The graphical scheme of off-site recycling is on figure 1. In this particular system we indicate a mutual relativity and links of individual elements in interest area. The solution of

this task is an achievement of economic criteria of recycling costs minimization. We have to calculate also with the costs, which result from legislative. The legislative obliges from the producers of waste [4]:

– to disposal of waste at own activities. Waste, which is not used by this way, has to be provided to another subject for disposal,
– to provide a waste treating, when the waste disposal is not possible,
– to transfer the waste only to subject, who is entitled to waste disposal.

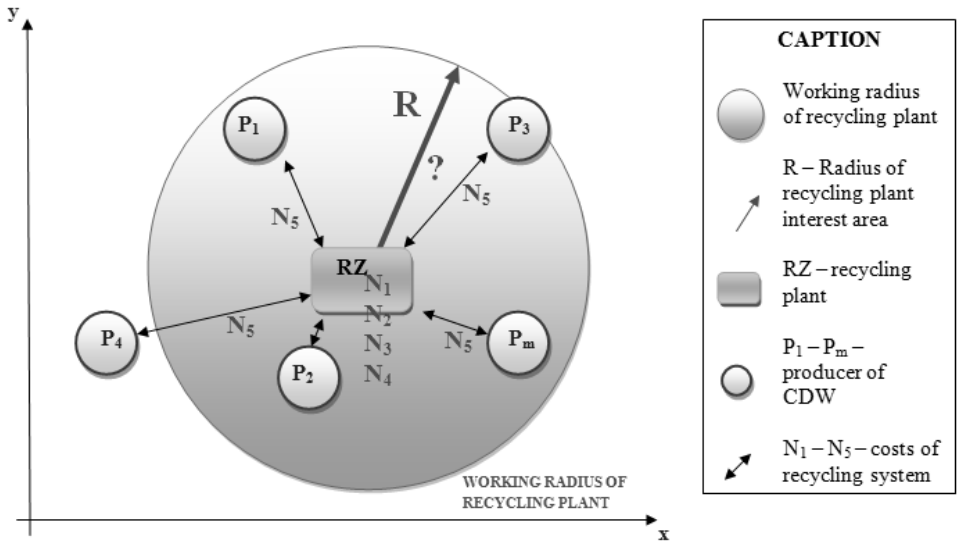

Fig. 1. Schema of off-site recycling and radius of recycling plant interest area

Rys. 1. Schemat utylizacji *off-site* (poza miejscem) oraz zasięg obszaru zainteresowania zakładu utylizacji

The off-site recycling system is created by two basic elements:

– producers of CDW,
– recycling plant.

CDW producers produce the waste by their activity. Waste presents the inputs into the recycling process. The companies, which carry out *the recycling plants*, present the second part of recycling system. The CDW presents „input material" for particular recycling process. The outputs from this process – recycled material are full-value and competitive material, which has an own place on the market with building materials.

The interactions among the elements of system are divided into two basic types of costs:

- costs of CDW recycling plants:

– CDW storage costs (N_1),
– CDW separation costs (N_2) – according their composition and types,
– variable costs of recycling plant for performance of own operation (N_3),
– capital costs of recycling plant for performance of own operation (N_4),
– transportation costs of CDW recycling system (N_5).

N_1 – costs for storage of construction and demolition waste presented the financial costs, which originate at recycling plant for the storage of 1 ton CDW transported from waste producer to recycling centre. But these costs are paid by producer of CDW. There are expressed as a tariff for storage of 1 ton SDO.

Analogous, we are able to express the *costs for separation of construction and demolition waste* N_2 which are related with the waste setting and separation after it transport to recycling centre. These costs are put on a tariff for separation of 1 ton SDO, which are paid by producer, as well.

N_3 – variable costs of recycling plant for performance of own operation present the costs of recycling plant, which are paid by its. It is able to expressed by costs per 1 working hour of recycling link, power of recycling link and amount of produced waste in interest area.

N_4 – capital costs of recycling plant for performance of own operation are last type of costs, which are originated in recycling plant, but do not relate of volume of its production. These costs express financial resources for providing of CDW treatment in recycling centre. It is mainly the elementary investment of recycling plant operator to the purchase of machines of centre, its needed areas. We can predict that, the radius of interest area is directly proportional whit the demand on needed areas of recycling links and other machines of recycling centre (feeders, lorries). The capital costs of recycling centre are depending on size of interest area and can be expressed as a summary of primary capital costs (are paid before the start of recycling plant service) and secondary capital costs (are related whit the expansion of recycling centre interested area).

N_4 – transportation costs of CDW recycling system present the financial sources for the transport of waste from the place of waste origin to place of waste treatment – form the waste producer to recycling plant. They are express as a product of average distance in the interest area, total CDW volume produced in this area, transportation rates for the transport of CDW 1 ton to recycling plant and radius of interest area.

The demand and the main optimising criteria is a value minimization of objective function. The basic form of this function can write as a summary N_1–N_5 costs. That means that during the recycling system selection process and radius estimation of interest area process, the lowest value of objective function will be determined. We can claim that, when we select the function with the lowest value, then we find out the optimal solution of particular issue from point of costs.

3. Conclusions

Many our sources are unrenewable and finally are finished. Therefore the society have to save the material and to make the most of recycling its. In term of it, the recycling of construction and demolition waste has a significant place at environment protection. The exploitation of recycling plants existed capacity demands the knowledge of optimal radius of interest area for the exploitation of existed recycling machines power, eventually for the completion of existed capacities.

This article presents a partial result of project VEGA n. 1/4196/07 *„The optimal radius estimation of interest area plant for construction and demolition waste treating“*.

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