Proposals for good practices in implementing the principles of the circular economy

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Introduction

At a global level, the natural resource crisis is becoming more acute. Statistics show that for the year 2022, 28th of July represents the peak of resource consumption- all resources produced in 2022 were consumed up until this date.

In this regard, a defining element for sustainable development, without which the increase in welfare is impossible, is circular economy- an approach based on energy efficiency and decreased greenhouse gas emissions. Circular economy is a rather new concept, introduced and used only during the second half of the 20th century. At the final stage of a product's life cycle, the use of natural resources in agriculture, industry and other human activities creates considerable amounts of waste with a significant negative impact on the quality of the natural environment and the health of the population. According to a news report of the European Parliament on the 12th of October 2022, European countries produce annually approx. 2.5 billion tons of waste.

In Romania, the utilisation rate of circular materials (a rate measuring the contribution of circular materials to the total utilisation of materials overall) is 1.3%, while the European Union's average is about 12.8% (according to the National strategy for circular economy, 2022). Romania has the lowest number of patents for recycling and raw materials per capita, an issue mostly connected to political, administrative, and financial factors (National strategy for circular economy, 2022). However, considering a low generation of waste per domestic raw material consumption, there are positive prospects regarding a best practices approach for circular economy (Dobre-Baron *et al.*, 2022)

The present paper will propose several solutions based on two of the three fundamental principles of circular economy: elimination of non-recuperable wastes and the regeneration of natural ecosystems. the proposed solutions refer to the use of residual wastes that are at present eliminated by disposal, more specifically, the ash resulted from the energetic vaporization of the wood waste produced by an economic operator in the biomass based thermal plant. The ash is produced from the burning of wood waste generated from a wood processing production line for chipboards and a production line for OSB plates. The main types of waste are peels from debarking and wood dust from the process of cutting the boards into smaller sizes and from the sieves for the qualitative and quantitative sorting of wood chips.

Methods and materials

A concrete production recipe for pavers (useable on pedestrian walkways or in parking lots) was developed, the final composition being established after subjecting the concrete samples to laboratory tests to determine the compressive strength. We used existing mineral resources from within an area of a maximum of 15 km away from the place of ash production and additives, cement that can be purchased in the immediate vicinity, so that the carbon footprint due to the transport of materials remains as small as possible. The determinations were made by compressive stress perpendicular to the direction of the generator, using a hydraulic press (figure 1):

Fig.1. Determination of compressive strength in the laboratory

The tests were carried out at the time intervals: 7, 28, 90 and 180 days.

For the second proposal for the use of ash, the analysis reports made available by the company were used.

Results &Discussions

The final recipe established by following specific determinations for pavers contains the following: ash; cement CEM II/B-M 42.5N; sand granulometry 0-4 mm; 4-8 mm gravel size; 8-16 mm gravel size; water; Chryso 206 superplasticizer additive (quantities can be specified after approval/certification). The laboratory results are shown in table 1:

Table 1. Mechanical-physical characteristics of concrete for pavers

Density of fresh concrete (kg/m3)	Compaction (mm)	Average compressive strength(N/mm)			
		at 7 days	at 28 days	at 90 days	at 180 days
2390	20 (S1 class)	29,6	37,2	34,0	43,5

As seen in the above table, the compressive strength increases, therefore the use of fly ash for the production of pavers is beneficial and economically viable.

According to the analysis bulletins provided by the economic operator whose activity produces the ash as residual waste, the ash is described by the following physico-chemical parameters (table 2):

Table 2. Physico-chemical characteristics of ash

pH	Dry matter content (%)	P (mg/kg dry matter)	Ca (mg/kg dry matter)	P (mg/kg dry matter)
11	93	515	16600	3720

Starting from this set of data, the possibility was analyzed (in a project proposal under evaluation) to use the ash for the ecological rehabilitation of the tailing dumps from the exploitation and preparation by autoclaving of sulfur in the Călimani Mountains (Negoiul Românesc – Pietricelu- Călimani mining perimeter) from the North-Eastern area of Romania. Through the mine closure plan financed from the state budget, works were carried out to secure the extractive waste deposits and only partially to arrange their surfaces (which constitue the upper platforms and approx. 30% of the surface of the slopes) for sowing grassy vegetation and planting tree vegetation.

The area proposed for improvement to seed with grassy vegetation is 39.6 ha. The material deposited in the tailing dumps is altered and unaltered pyroxenic andesite, white siliceous rock bearing mineralization, unsaleable degraded technical sulfur. From the analyses carried out on the samples taken from the dumps and their bordering area, it was found that the pH is strongly acidic, varying between 2.02 and 3.5. The composition and the physico-chemical characteristics of the tailings, the geometry of the dumps means that, at approx. 27 years after the cessation of activity, they should not show traces of naturally installed vegetation. This fact facilitates the instability of extractive waste deposits, with the contamination of the adjacent surfaces.

It was proposed to spread a mixture of ash as an alkaline treatment and peat as a fertilizer (exploited deposit located at the foot of the Călimani massif): 17560 cubic meters of alkaline ash and 21750 cubic meters of peat and seeding with grassy vegetation specific to the area. This was followed by the planting of tree saplings (Swiss pine, spruce, juniper, birch, alder, buck willow) in tree pits with their roots protected in the pits, at the bottom with ash as an alkalizing layer to prevent acidification of both the soil and underneath the soil layer, followed by sawdust compost, local soil, at the density of 5000 pcs. /ha.

Conclusions

The paper proposes two methods of industrial symbiosis for a superior use of a residue: fly ash and wet ash (code 10 01 01) from a biomass thermal power plant, which is currently disposed of through waste storage. The valorization of the ash can be achieved through the following methods:

- waste ash can be sold on the market and used to produce pavers.
- waste ash can be reused by another company for the improvement of the surfaces of extractive waste deposits for the purpose of greening. The amount required only for the Călimani site represents the production of ash for 1.5 years.

In Suceava county alone, there are more than 1200 hectares of extractive waste deposits that need to be greened.

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