Chapter

Hazardous Waste Granule Composting by Cycled Retort Using Microwave Radiated Asphalt/ Asphaltite Coal Slime Mixing

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Abstract

The hazardous sludge metal content of Mazıdağı metal leaching and electrowinning plants causes a great threat to ecology. The high-level metal and salt contaminants occurred in the copper leaching waste tailing ponds. The seepage liquors leak through the permeable bottom of ponds, such as acidic seepages. While urbanization needs freshwater; freshwater demand in the region increases because of global warming and drought. The estimated contamination values are avoided designing the controlling contamination level systems and meeting the disposal compost demand. In this approach, the demand for land covering and compost disposal has been designed as pellet or granule units determined independently of the specific needs of fertilizer products, agricultural remediation, and human needs. The amounts of sludge and wet hazardous toxic waste sludge's of Mazıdağı Phosphate Plants of Eti Bakır in Mardin change the ecosystem. The hazardous sludge of plant tailings is needed planned paste disposal or controlled regional dumping, pool effluents barrier on regarding seepage control demand of the freshwater lake of town region. The planned work is disposal tests for waste sludge composting as pasting. Additionally, this method protects ecology and improves waste sludge disposal by neutralizing it at a small scale. Even the toxicity will be easily monitored. Heavy metal contamination hazard maps will be prepared and an agricultural warning system will be established for agricultural irrigation.

Keywords: pasting heavy metals, microwave melted asphalt, shale, biochar, waste granule, hazardous industrial waste, sludge, road pavement

1. Introduction

Microwave radiation creates energy increase in the mineral crystals by friction so as the material body can partially permit radiation. Hence, thermal body heat increases with mechanical vibration stress. In that circumstance, the mineral crystals can generate thermal crack space regarding the permittivity and contents. In this study, the easy heating to 90°C, over the effect of microwave energy managed the melting waste sludge with asphalt bitumen contents in the retort reactor. By the melting character of

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asphalt in the furnace during that process, Şırnak asphaltite slime, a type of bitumen coal was investigated for compaction change and compressing period.

Aggregate is the main raw material of road superstructures as in many construction manufacturing. The properties of the aggregate, which forms a large part of the bituminous hot mix used in the superstructure, greatly affect the mixing performance. Therefore, it may be difficult to obtain aggregates that provide the required properties for BSKs and the aggregate costs are higher [1–4].

Hazardous radioactive or wet industrial sludge wastes processed for the recovery of metal with sulfuric acid, and methods for oxidized products with decay for acidic harmful substances. Thus, both soil wastes, complex carbon of sludge, and agricultural biomass wastes are evaluated. As well as other organic materials such as iron slime material and cellulosic material, they can be evaluated for high wetness. This waste was mixed by cleaning the acid mixture of the waste industry iron and chromium foundry sludge by pelletizing it with salt and mixing with the pelletized to cellulosic with exposed to decay time. This alkali salt is further salted then trapped. Disposal of sludge covers for scrapping has been examined on the impervious barrier at the bottom of large pools. As the coating of the bitumen mixture of the block pond size of these sludge wastes, the acidic solution with a solids content of 11.5% and hazardous radiation and the asphalt covering 10 mm hazardous wastewater pellets were degraded there in the dimensions of 10 mm. With this storage method, water resources are conserved and agricultural settings are also advantageous for improvement and environment. In our country, it is spread over a wide area outside the wide rocky soils in Siirt and Hakkari. The seepage of heavy metal ions or acidic chelate, mixing to streams should be neutralized by oxidizing reagents such as ozone or neutralizing alkaline washing so that it is reduced effluent contamination by high levels of heavy metals. The waste leaching liquors such as Hg, Pb, Cr, Cd, Cu, Zn, Fe, SO4 rates were contaminated freshwater sources near urbanization areas. The oxidation recycling of residual fly ash contaminated waters was a serious threat to the radioactive level. The hazardous chemical substance reacting that deteriorated environment was eliminated by pasting asphalt mixture and the following use as road pavement or filler source for waterproof barrier construction (**Figure 1**).

The Mazıdağı urbanization fieşd and freshwater dam lake, Mardin city is getting high ecological water safety threat on its population and density of immigrants by metal leaching phosphoric acid and sulfuric acid usage increase, its seepage, soil quality, and quantity of heavy metal in the soil. The main purpose for hazardous waste management in the Mazıdağ Phosphoric Acid and Electrowining Plant is easily controlled deposition of waste sludges without affecting water contamination. The water treatment plant in Mardin Eti Bakır Mazıdağı Plant will improve drinking water quality to be preserved. However, tailings containing hematite and iron sulfide with a high amount of sulfate and phosphate salts and tailing ponds water greatly threaten the ecology and near agricultural fields with a lack of irrigation.

1.1 Asphalt composting

The compost sludge volume was 10–20% in pasting, 90–95% of the volume was compost filler matters, 15% of the volume consists of fly ash fines [5–8]. The primary or secondary cause of compaction in paste and asphalt composts deteriorates the use of unsuitable coarse aggregates or the use of aggregates containing undesirable shaped substances [7–14].

Type of aggregate surface roughness, flatness, gradation, such as the characteristics of the bitumen binder thaw fatigue and tire performance has great importance on the

Figure 1.
The 3D view of Mazıdağı, Mardin. EtiBakır Mazıdağı phosphoric acid, sulfuric acid, metal leaching, and metal electrowinning plants.

asphalt composite track [14–21]. Aggregate-asphalt mixtures must meet certain requirements to be used as a pavement. These conditions are given in the Technical Specifications for coatings [21–24]. Natural stone crush aggregates are preferred in road superstructure construction in our country. But in many countries, natural aggregates as well as, artificial aggregates have been used in road construction. Aggregates are grouped as light, normal, and heavy aggregate considering the unit weight. These aggregates used in road construction in our country are mostly included in the normal and heavy aggregate class. In recent years, the use of artificially obtained light aggregates in road construction has found application in some countries.

The use of microwave melting in the production of asphalt composts reduces the use of cheap filler waste raw material resources, even the removal of sludge waste and controlled dumping requires substantial environmental benefits. In addition, the usage of fly ash in the asphalt compost production process allows the recovery of non-hazardous waste materials; thus, freshwater management, ecological, and economic benefits [25–34].

In this study, first all experiments were carried out to determine the physical properties of natural crushed stone aggregates and fly ash to be used in the mixture [34]. Sludge waste-melted asphalt briquettes were produced using Şırnak quarry limestone and asphaltite slime, aggregate using limestone, and char as compost mixing aggregate

The area was chosen as tailing pond area about 500 m away from the quarry and the sludged matter is wet at that 14 and 23.1% water of the dumping site near the Mazıdağı freshwater lake. Tailing ponds of metal leaching unit is near freshwater dam lake. On this lack of water for irrigation and drinking water demand of plant suffers from a relatively high potential of instability of tailing effluents seepages to groundwater levels by flood hazard and heavy rains. Geolayers for tailing ponds is providing control of the heavy metal-containing effluents seepages.

Şırnak asphaltite slime in the evaluation of local natural filler allows the production of bitumen binding strength of paste [14–16]. Weak strength of paste of asphalt compost reduces the contamination by increased fly ash filler use [17–19]. Plant for pasting of heavy metal sludge and composting by coal waste slime of Şırnak will improve drinking water quality to be preserved in Mardin.

2. Methods

The sludge matter hazards are seen on the ground come to seepage over the agricultural and freshwater sources in the area. In this case, it is clear that toxic parameters on the sludges will be compacted in the laboratories, avoiding the permanent dissolution values over 325 ppm to below 413 ppm–52 ppm. In this study, the toxic metal contaminants at lower levels than the threat level are about below 10 ppm. However, it was over 210 mg/l with some near groundwater wells and wet soils with leaks by uncontrolled seepages near tailings pond in Mazıdağ EtiBakır Plant area.

The well water heavy metal contamination levels were determined as given in **Table 1**.

Effluent, mg/l	Tailing ponds sludge1 effluent	Tailing ponds sludge2 effluent	Tailing ponds sludge1	Tailing ponds sludge2	Well 1 irrigation soil water	Well 2 irrigation soil water	Dam irrigation soil water
Cu	780	780	12.3	14.11	70	4.71	4.71
Pb	158	158	23.2	12.58	18	5.7	5.2
Fe	403.3	403.3	59	93.3	43.3	60.62	67.62
K + Na	852	852	8.7	8.52	552	≥70	≥50
Cd	276.2	276.2	14.1	14.72	47	16	15
Mn	123	123	24.2	43.3	13	≤25	≤25
Zn	372	372	15.7	7.2	57	≤15	≤15
PO4	1010	1010	2.8	2.10	220	≤5	≤5
SO_4	5700	5700	1.9	0.67	670	≤15	≤15
Solid, ppm							
Cu	124.1	124.1	52.3	48.71	40.71		
Pb	312.5	312.5	23.2	24.53	11.53		
Fe	444.3	444.3	5.9	7.62	5.62		
K + Na	747.5	747.5	81.7	81.46	88.6	≥70	≥50
Cd	246.7	246.7	10.1	9.56	19.56		
Mn	272	272	1.5	3.02	1.02	≤5	≤5
Zn	3330	3330	2.4	2.41	2.41	≤5	≤5
PO4	11,065	11,065	2.8	2.44	2.44		
SO_4	5798	5798	1.9	0.37	0.55		

Table 1.
The metal contents of the tailing pond sludges of the Mazıdağ EtiBakır plant and the potential soil well waters.

Component %	Şırnak asphaltite slime	Şırnak shale	Şırnak asphaltite char	Mazıdağı waste sludge	Şırnak asphaltite coal fly ash
SiO2	43.1	50.50	50.50	60.13	41.4
Al2O3	13.3	12.61	14.61	17.22	18.1
Fe2O3	9.5	14.30	24.30	4.59	4.2
CaO	7.4	12.30	2.30	2.48	18.4
MgO	3.7	2.3	1.28	2.17	4.0
K2O	2.5	2.0	2.51	3.51	2.1
Na2O	1.3	1.3	1.35	4.35	1.5
Ign.Loss.	38.9	6.6	12.21	4.12	1.6
SO3	0.2	1.2	0.12	0.52	0.2

Table 2.
Chemical composition of fillers of char composite present in the hazardous sludge pasting sample.

Char sludge and asphalt composite compaction as the mining wastes was also decreased the permeability of bottom layers in the dumping mining landfill field. The chemical composition of asphalt paste compost matters is given in **Table 2**.

2.1 Microwave asphalt -char -sludge compost melting

As a result of the Marshall calculations to determine the optimum amount of asphalt and type for high compaction is made with all three correlations, it is clear that if the lower limits of the aggregate types given in the specification are used in the sludge asphalt paste mixtures, a low binder will be required and the cost of the mixture will decrease. Bitumen properties of the sludge asphalt paste are given in **Table 3.** The physical properties of each produced sample were determined. The water sorption and porosity of the samples were determined by a series of soil standard experiments. In addition, compost quality comparison is made considering the use and supply of the waste materials used.

This study determined optimum volume reduction by compost compaction at finer particle size fraction rates and distribution factors for compaction to packed density.

Bitumen properties	
ASTM test	**Ortalama Değerler**
Penetration (25°C)	60–70
Flaming point	180°C
Ignition point	230°C
Melting point	45.5°C
Ductility(5 cm/min)	>100 cm
Specific gravity	1034

Table 3.
The bitumen matter properties in the asphalt pasting sludge studies.

Test, 0–4.75 mm	Şırnak asphaltite slime	Şırnak asphaltite char mm	Şırnak fly ash	Standartlar
Water sorption (%)	3.54	1.63	0.81	ASTM C 127
Los angeles (%)	27	26	23–38	ASTM C 131
Fineness (%)	15.5	3.7	4.5	ASTM C 117
Organic matter mad.	—	—	—	ASTM C 40
Thawing (%)	11	9	7.7	ASTM C 88
Abrasion (%)	—	≥%50	≥%50	
Density (gr/cm^3)	2.576	2.642	2.677	ASTM C 127
Rough weight (gr/cm^3)	1.61	1.40	1.41	ASTM C 29
Compact weight (gr/cm^3)	1.91	1.62	1.64	ASTM C 29

Table 4.
Granule properties, fineness of Şırnak limestone compost fillers present in the composite sample regarding ASTM standards.

	Şırnak asphaltite slime	Şırnak asphaltite char	Şırnak fly ash
Density (gr/cm^3)	1.855	1.655	1.855
Rough weight (gr/cm^3)	1.32	1.23	1.32
Compact weight (gr/cm^3)	1.84	1.84	1.94
Water sorption (%)	14.5	15.5	17.5
Moisture (%)	0.2	0.1	0.2

Table 5.
Şırnak Asphaltite slime, char granule properties, fineness of Şırnak char and fly ash fillers present in the composite sample.

Finally, a compaction volume rate of 32% could be managed by microwave melting and following pressing under 3 tones load for 50 mm diameter mold.

The physical and mechanical strength values investigated are given in **Table 4** with respect to standards. The oil addition as easy pressing through the mold in compaction is optimized at below 150-micron particle size fractions. The bitumen content was recovered back with a 95.7% recovery rate in compacting fine solids as given in **Table 5** following microwave melting.

2.2 Grain size analysis

Ground samples are sieved as mentioned in the standard method and sedimentation test. The particle gradation and size distribution were determined according to the chart in **Figure 2**. **Figure 3** shows the gradation of asphalt paste fillers (ASTM C136) [11].

The sludge wastes in the Mazıdağ tailing pond are given in **Table 1**.

2.3 Experimental pasting melted asphalt content calculation

The gradation factors and formula is the oldest McKessen - Fricstad formula for calculating asphalt content. The proposed binder addition amount is determined by the formula given below for asphalt bitumen bound aggregate composts [11, 12].

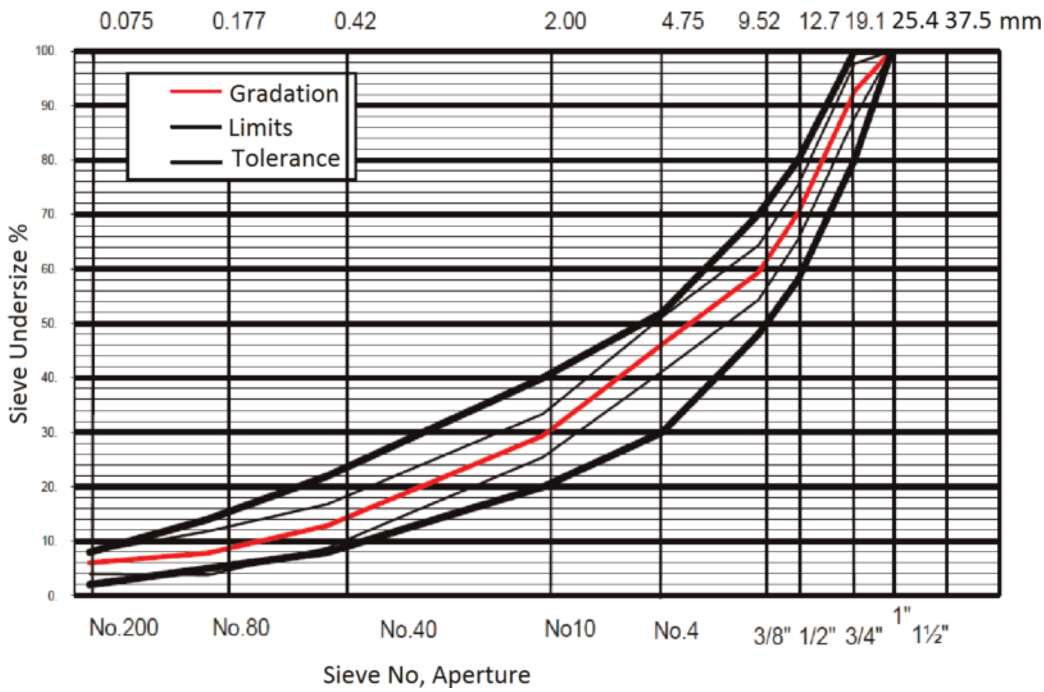

Figure 2.
All of the base and bottom base layers without binders are weighted by bituminous hot mixtures.

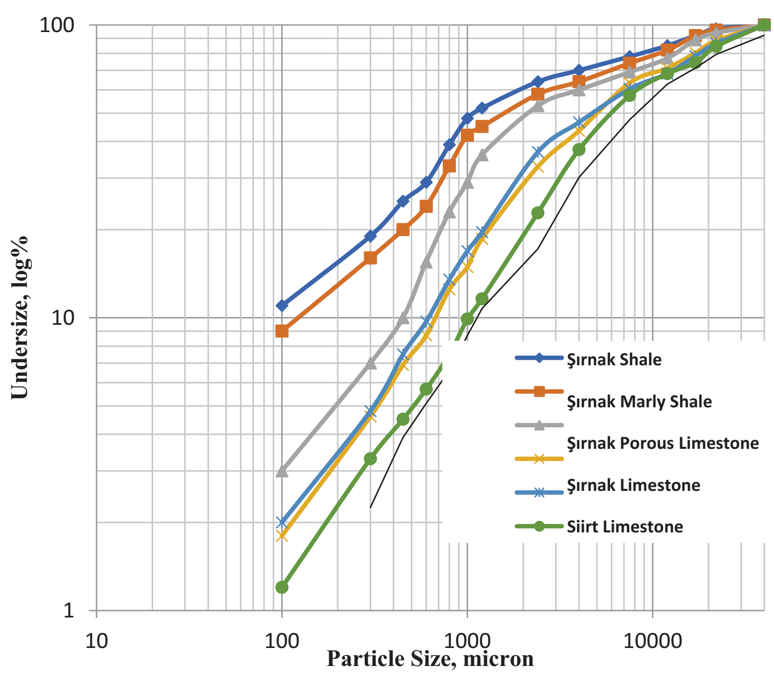

Figure 3.
Changes in Gaudin-Schumann particle size distribution of paste filler material.

$$p = 0,015\,P + 0,4\,S + 0,2\,F$$

P: Binder content in% by weight of aggregate a:% of aggregate remaining on sieve No 10.

S: 1% by weight of aggregate remaining between sieves No. 10 and 200.

F: % by weight of the aggregate passing through the sieve No.200.

The amphoric formula is commonly used in the gradation calculation of the compacting paving rock with asphalt. The bitumen content in asphaltic mixtures was determined by the following correlation.

$$SI = k\,\gamma\,\sqrt[n]{0,015\,C + 0,4\,S} + 0,3\,P$$

P: Asphalt content of % by weight of aggregate specific gravity of aggregate distribution factor α = 2.65/γ

$$\alpha = 0,015\,n + 0,4\,F$$

γ: Aggregate specific gravity.

k: Aggregate wealth module (3 to 3.5 coefficient).

F: Aggregate fine content %.

S: specific surface area of aggregate (m^2/kg).

Total Shear strength = 0.25G + 2.3P + 12SI + I35F.

G:% by weight of aggregates greater than 6.3 mm.

S:% by weight of the aggregates remaining between 6.3 mm–0.315 mm (# 50).

As it is seen in both experimental methods and empirical relations, an important factor affecting asphalt content is the aggregate gradation used to determine the asphalt content in asphaltic mixtures. The effect of aggregate gradation on the asphalt content was investigated in three parts. In the first part, binding contents of binder and wear layers aggregate gradations were found. In the second part, we investigated how aggregates passing through screens 1/2 ", 4, and 8 affect the contents of the binder.

The asphalt contents required for the lower and upper limits of the compost gradations are illustrated in **Figure 2** using the ASTM standards [14]. In **Figure 2**, the aggregate gradation for road pavement requiring at least asphalt content for the binder layer is the lower limit of type 3 providing high stability strength under layer. The upper limit of type 2 is within the upper limits providing high wear resistivity on the road pavement. For the ductility, it is type 1, which requires the medium binding content among the lower and upper limits of gradation.

2.4 Los Angeles values

The standard abrasion criteria of aggregates are determined by standard tumbling tests giving values of shattering by water and tumbling act [15]. The Şırnak asphaltite, shale, and char show low durability values in Los Angeles values among 40–55%. Regarding grain size of limestone aggregates, the compost properties are given in **Table 6**.

2.5 Microwave melted, compacted/briquetted Sludges

Stability is a significant parameter of compost impermeability for sludge paste avoiding contact with water sources in the landfill. The lowest asphalt binder at 3.5–4% weight rate in the compost increase the wear resistivity and stability high enough to resist compaction loads and contact to potential water seepages.

	Şırnak limestone			
Size, mm	**0–4.75**	**4.75–9.5 mm**	**9.5–25**	**Standards**
Water (%)	* (3.54)	1.63	0.81	ASTM C 127
Los Angeles (%)	44	55	73.804	ASTM C 131
Fine (%)	11.3	1.27	0.45	ASTM C 117
Organic binder	Berrak	Berrak	Berrak	ASTM C 40
Thaw. (%)	*	*	6.69	ASTM C 88
Abrasion. (%)	*	%50 'den Fazla	%50 'den Fazla	
γ Density (gr/cm^3)	2.576	2.642	2.677	ASTM C 127
Rough density γk gr/cm^3)	1.61	1.40	1.41	ASTM C 29
Compacted density (gr/cm^3)	1.91	1.62	1.64	ASTM C 29

Table 6.
The physical parameters of Şırnak limestone in paste compost.

However, very high stability means a very hard pasting mixture even a high amount of fine fillers for sludge pasting was required. On the other side ductility and durability decrease for the pastes by a high amount of thermal or stress cracking. The microwave heating provides the low asphalt content use in pasting and even easier compacting in this study. Although the asphalt leak of 0.1% occurred in the tests gasoil was used emulsification of asphalt due to reducing heterogeneous mixing and easy wetting. The high compaction of sludge and use of fly ash at 20–25% volume rate increased compaction ability and reduced the permeability. The permeability of sludge compost shows the resistance of the asphalt coating to the passage of air or water.

The permeability over 10^9 D is wished from waste pastes to avoid the hazardous effect of sludge contamination to the soil or water sources.

The impermeability is determined by the percentage of air voids in the mixture of low asphalt percentage and high voids in the design make the layer highly permeable.

By the way of microwave radiation at 10 minutes period increased compaction load to 1500 kg with 20 mm shear compaction distance in the barrel of 70 mm diameter of test mold. The followed process in sludge pasting is illustrated in **Figure 4**.

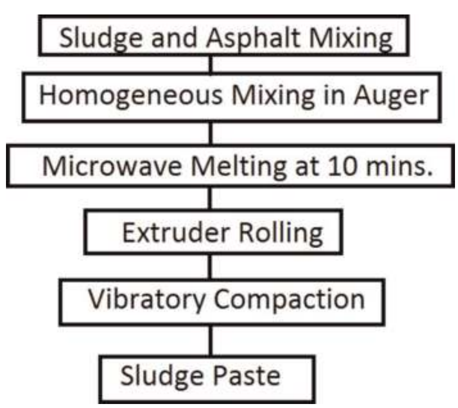

Figure 4.
Microwave experimentation flowsheet for sludge pasting with asphalt.

3. Results and discussion

3.1 Char compost compaction strength

The hazardous sludge threat is widened in similar areas. The urbanization districts which are at 1 km distance to Mazıdağı on the north of the Metal recovery plant and the tailing pond area of Mazıdağı Plant (**Figure 5**) were examined with permeability and hydrology of land in different locations at 100 m away. However, in this study char carbon reduces to contaminated soil and irrigation water sources by metal absorption ability. 20–10% volume rate of char in the compost will decrease dissolution amount to water at ten-fold times by homogeneous mixing under microwave melting radiation on surface interference. The compaction ability is even increased absorption amount by addition to char and coal slime to the pasting. The coverage binding bitumen and wetting effect of asphalt is improved by the addition of char carbon content of compost.

3.2 Fine fraction of the hazardous sludge compost

In the present study, the microwave melted mixture of a Sirnak asphaltite slime below 100 microns as a carbon sample with coal pyrite improved the microwave melting effect before compaction. This resulted in almost complete melting of the compost sludge and ash material as seen in **Figure 4**.

3.3 Compost granule gradation

The medium-coarse content at 4.5 mm–2 mm provided the well gradation and optimum pasting method at an amount 25% weight rate compost fillers as illustrated in **Figure 6**. The finer size below 0.2 mm increased 50% weight rate determines the lowest asphalt content of the paste gradation used in the sludge mixture depending on the surface area. In this method, we briefly follow the following mixture types as given in **Table 7**.

The binder percentages are about 4.5–5% weight rate corresponding to the optimum compaction value so as the percentage of the space specified in the compaction. The binder compaction space percentages are the percentage of asphalt volume collected. The arithmetic averages of the bulk content were found as the best compaction

Figure 5.
Satellite view of Mazıdağı, Mardin. EtiBakır Mazıdağı metal leaching and electrowinning plants.

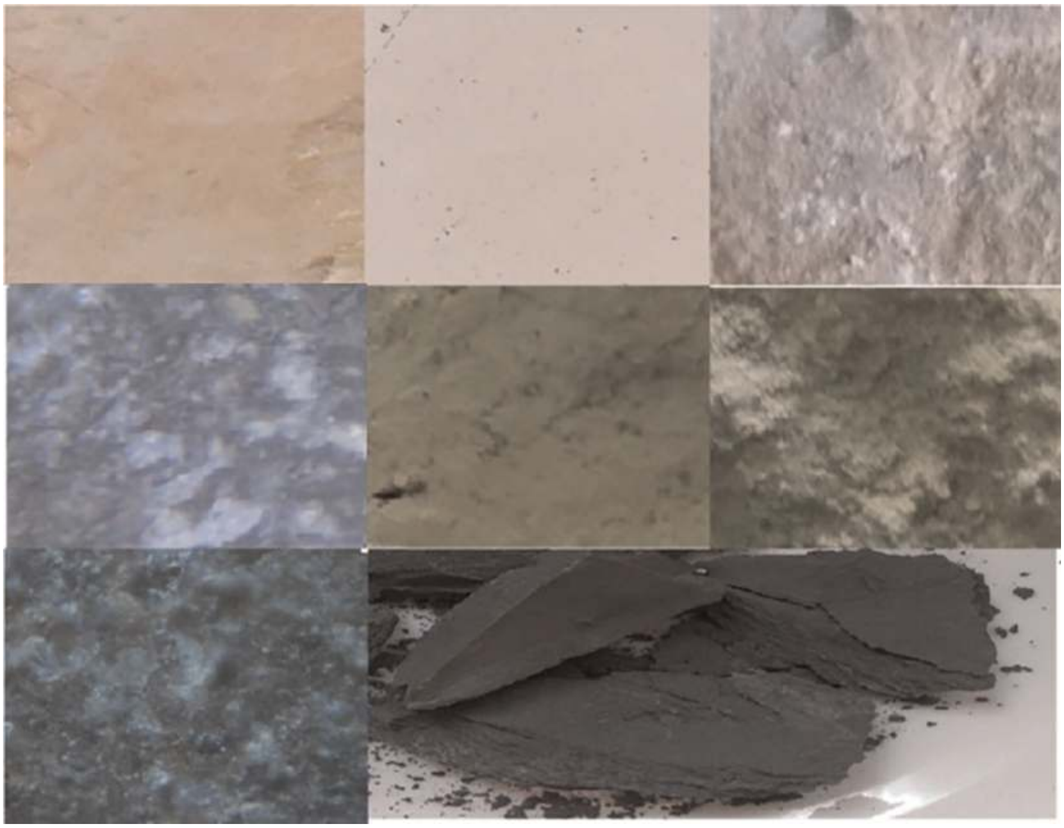

Figure 6.
Views of marl of Sirnak, limestone b, and c, d. after chemical interaction aggregate image.

Mixture component %	Sludge waste/ slag char	Sırnak limestone	Şırnak marl	Fly ash	Asphalt
A	65	3	2	25	10
A2	65	3	2	20	10
A3	55	5	5	20	15
C	65	4	1	20	10
C2	60	4	1	20	15
F	65	9	1	20	10
F2	60	9	1	20	15

Table 7.
Char, Şırnak asphaltite sludge compost paste filler matrix composition in Şırnak City.

asphalt content (the percentage of the aggregate weight in the mixture). This value is checked on the yield curve and the corresponding flow value is checked for compliance with the specification.

3.4 Compaction

The filler materials used in the pasting compost at 20% volume rate are viewed in **Figure 6**. Shale particles contained high porosity reaching 7.8% in the compost. The

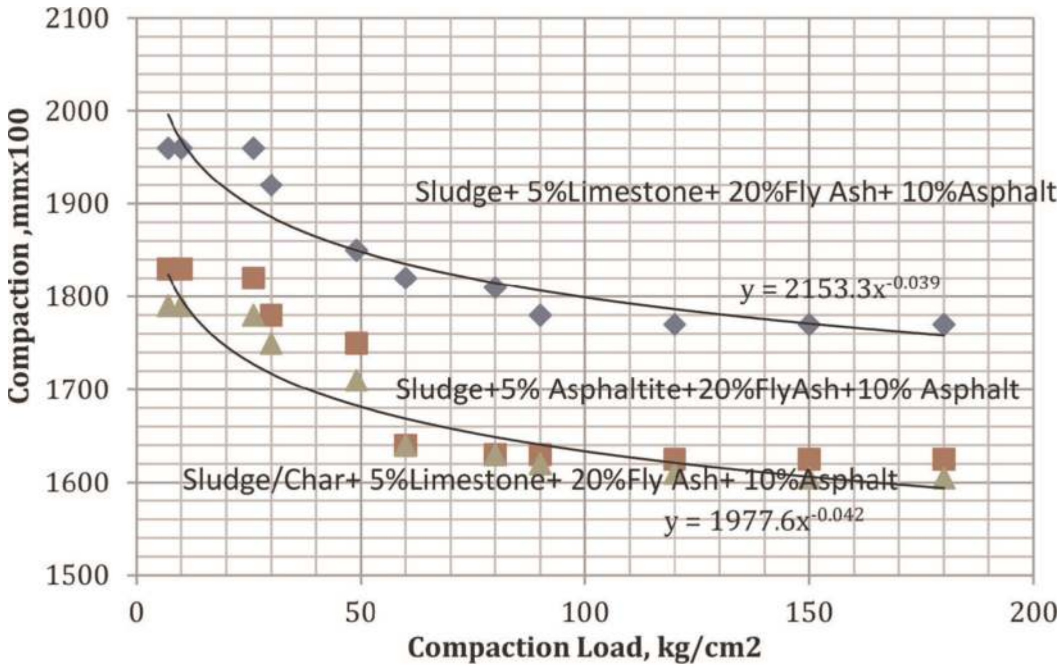

Figure 7.
Relative compaction changes of paste fill with Şırnak limestone, asphaltite slime char, and Şırnak shale after load indentation.

limestone's water absorption values were lower with asphaltite slime at about 2–3.5%. The filler mixing combinations are given in **Table 7**.

The effect of fly ash and Şırnak asphaltite and shale on compost density with asphalt mixing is illustrated in **Figure 7**.

In this study, the mechanical properties of local limestone and mine waste stone of Şırnak asphaltite slime and shale are used as filler for the purpose of asphalt sludge filler paste production. The waste slime asphaltite and Şırnak char are ground below 4 mm at the coarser part of 5% weight ratio. Şırnak shale and 15% Silopi fly ash are prepared as a binder cementing matter of sludge mixture of paste. The pressed blocks were manufactured in 50 × 50 × 10 mm like pile blocks, 10 mm thick bending strength, impact resistance, friction, abrasion loss, compaction distance were determined by the experiments. The ability of paste in the pile blocks to compact loss asphalt bitumen and water desorption are analyzed.

These experiments show that local rock cement mixtures and elaborate the application of cementing technique with silica fume used and it prevents the coating applied to moisturize the strengthening of historic buildings Sirnak region as a result and is determined to carry out the consolidation.

3.5 Shear load and compression strength analysis

It is determined that the 90°C temperature accelerates the melting of asphalt bitumen. These technological applications can be further developed with the evaluability of local natural stone powder in paste backfill. The strength of sludge paste pile blocks produced is reduced 7.2 to 6.4 MPa. Lower asphalt weight increased mechanical strength of pasted pile block with compaction been advantageous. Thus, the ideal compacting load of 100 kg tight aggregates with the block and pasted block resistance of the produced slag mixture may arise from 8.3 to 9.2 MPa.

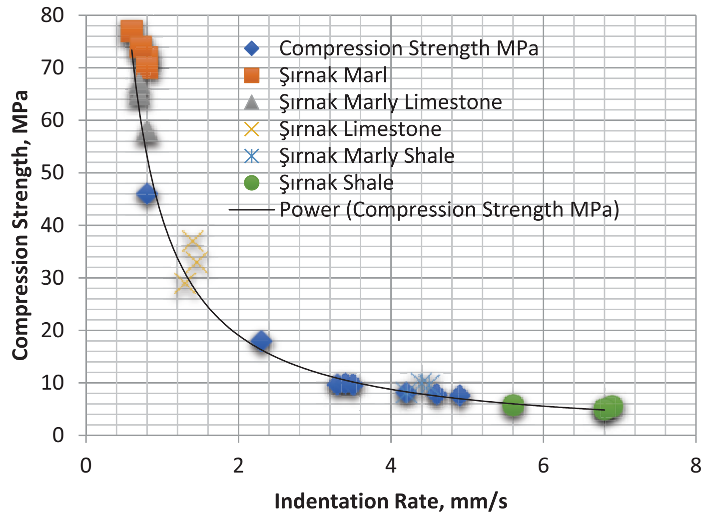

Figure 8.
Compression strength of paste fill material rocks.

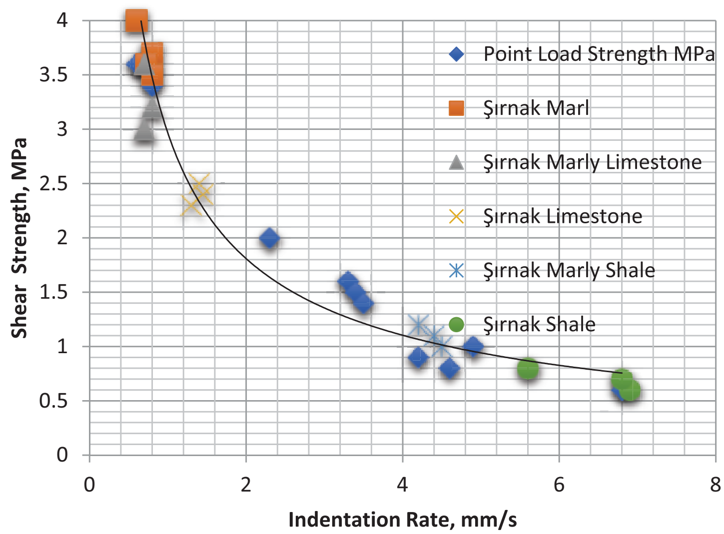

Figure 9.
Point load I strength of paste fill material rocks.

The results are shown in **Figures 8** and **9**. Indentation tests of the rock types were determined by a drill machine at 10 mm bit diameter due to the correlation of rock strengths underground mining cavity conditions.

3.6 Paste fill block production and compaction analysis

Asphalt and fly ash binders are raised to 10–45% weight ratio at different mixtures and 20% wet hazardous sludge and strength properties of prepared mixture paste with asphalt melted compost.

The water/binder (w/B) ratio is decided to be 20%/10–45% as a result of preliminary experiments. Pasting 5% melted asphalt is sufficient. The amount of each series fly ash composting fines are sorted asphalt and sludge in pile blocks and determined the compressive strength after drying blocks.

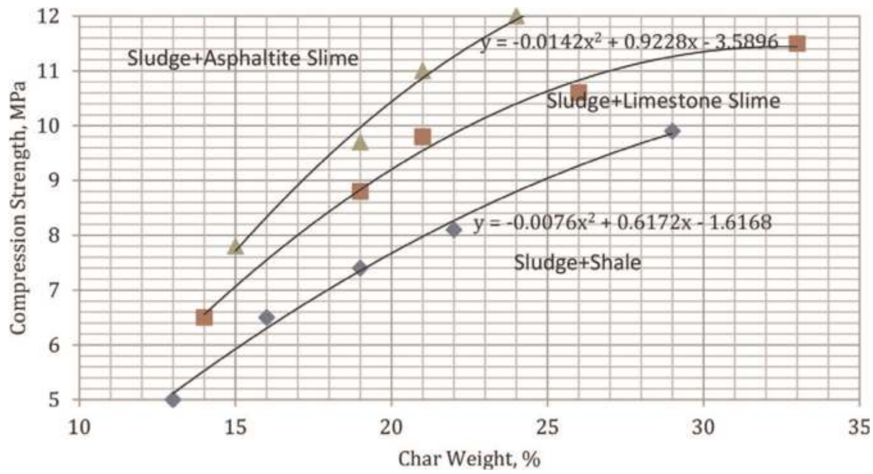

Figure 10.
Char addition weight of pile paste blocks with paste fill vs. UCS test results: 1. Shale 2. Sirnak limestone 3. Sirnak limestone.

4. Conclusions

Fly ash fine-texture and sludge mixing were homogeneous and the contamination act of sludge decreased at half amount rate by addition of 20% fly ash addition to paste mixture. The char carbon will also ten times decrease the metal contamination to water sources. The texture of low asphalt and emulsified hıgh bitumen content lowered the compaction resistance by increasing structure strength.

Especially the compact loading resistivity increased over 1500 kg for 70 mm barrel loading on which the resistance is kept as high as 20 mm displacement as high. Sand content of sludge was lower than the limestone so that this gradation provided high durability and less cracking during compaction loading final product briquettes and lower abrasion resistance.

Figure 10 shows the 1000 kg loading was suitable for long durability and optımum briquetting outputs. The stability was varied depending on the amount of fly ash and Şırnak asphaltite slime contained in the pasting relative to the pore contents in the micro-structural texture of asphalt compost. The pore density will decrease by low asphalt content and compaction resulting in the development of impermeable surface on the compost briquettes consequently.

The apparent uniaxial compressive strength test of Şırnak limestone showed sufficient substrate gradation and porous texture with high Los Angeles values of 67% at 4.5 mm granules. The gradation was suitable for high compaction ability and Şırnak limestone exhibited low porosity and water sorption 0.8%.

The higher compaction over 1000 kg provided sufficient permeability and compression strength values and higher shear resistance with lower cracking over time period of dynamical stress loads related to landfill application.

Symbols

τ kg / cm^2	Shear stress
σ kg / cm^2	Normal stress
Ip	Plasticity index

Ll	Liquid limit
Pl	Plastic limit
Wopt	Optimum water content
γ Natural g / cm^3	Natural unit volume weight
γsatg / cm^3	Saturated unit volume weight
γdry g / cm^3	Dry unit volume weight
γkmax g / cm^3	Maximum dry unit volume weight
γs g / cm^3	Grain unit volume weight
k	Permeability coefficient

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