A Detailed Review on Existing Landfill Liners and Performance of Recycled Coarse Aggregate as an Additional Layer

T. ANSTEY VATHANI [1] *, DR. J. LOGESHWARI [2]

1. **Research scholar, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai-6000062, India*
2. *Associate Professor, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai-6000062, India*

Abstract:

Landfills are used to dispose wastes such as food, e-waste, construction waste, metals, and medical waste. Globally, 2.01 billion tonnes of trash are produced. This article provides a detailed review of landfill liners and their degradation after few years of usage. Concrete recycling is the process of crushing, treating, and reusing construction debris gathered from construction sites. Currently, research is being conducted on performance of both landfill liners and Recycled Coarse Aggregate (RCA). The liners should be inspected regularly to prevent leachate damage and the use of cooling pipes reduces the heat generated between the liners. RCA has virtually the same qualities as natural aggregate, and using fly ash with RCA improves its performance. RCA resembles a good material that can replace natural aggregate. Leaching is one of the important processes in preventing the leachate from penetrating through the ground. clogging can be prevented by using pipes of variation in sizes such as 38 mm and 19 mm so that there is no clogging due to leachates [50] and removal of clogged substances. From the study made on various researches it could be concluded that RCA can be used as an additional layer as it enhances the performance of a landfill with very less or no extra cost.

Keyword: *Landfill liners, Performance, Recycling concrete, Recycled Coarse Aggregate (RCA).*

Introduction

Biodegradable waste, weeds, metals, concrete, and plastics are all accepted at landfills. 3.40 billion people could be on the planet by 2050. (Adapted from worldbank.org). It is necessary to collect trash, although the rates vary greatly according to income, with high-, middle-, and low-income countries collecting practically always. Only 26% of rubbish is collected outside of urban areas in low-income countries. Nearly 44% of waste is collected in Sub-Saharan Africa, while 90% is collected in Europe, Central Asia, and North America. Inadequate landfill construction can result in disease spread, soil and groundwater contamination, methane and carbon dioxide leakage, and more. Characteristics of new municipal solid waste (MSW) are critical in establishing new solid waste management frameworks. The major MSW qualities to evaluate are physical organization, moisture content, compacted unit weight, and porosity. For enhanced leachate recirculation (ELR) landfills, the physical and hydraulic features are critical in calculating how much moisture to recycle and planning the leachate recirculation and gas collection systems.

There are five phases of wastes in landfills namely Initial adjustment, Transition process, Formation of acid, Fermentation of Methane, Stabilization and final maturation.

 https://doi.org/10.37896/pd91.5/9159

ISSN: 0369-8963

Table.1: Phases in landfill construction and operation

Phases in Landfill construction and operation	**Initial Adjustment:** It's a process of aerobic degradation in the main acceptor. The vacuum section contains high level of oxygen. As the microbial material grows, increasing thickness.
	Transition Process: Due to the general current state of microbial compounds, oxygen is depleted almost immediately. Due to the decrease in oxygen, the high-impact and anaerobic conditions between the layers decline. As oxygen is quickly cleared by CO_2 in the profluent gas, the essential electron acceptors during progress are nitrates and sulfates.
	Formation of Acid: The acid arrangement begins with organic waste degradation, resulting in VFAs in leachate. Extended normal acid lowers pH to 5.6. VFAs produce a lot of COD during this time. Organic acid interaction causes acidic acid, CO_2, and H_2. High VFA raises BOD and VOA, which increases H_2-oxidizing infinitesimals. Hydrogen age is short since it precedes destructive strategy. Acidogenic bacteria biomass increase affects waste and food consumption.
	Fermentation Of Methane: Methanogenic bacteria convert organic acids to Methane and CO_2 during acid synthesis. Methanogens metabolize VFAs, neutralizing landfill water ph. CH_4 and CO_2 gas production reduces leachate's oxygen interest. Longest stage of degradation.
	Stabilization and final maturation: As the micronutrient reserve is depleted during waste digestion, microbial growth slows. For example, bioavailable phosphorus depletes. After entering the gas wells, High oxygen from the lower environment causes a complete stoppage of CH_4 production. This raises leachate ORP (Oxidation-Reduction Potential). Dirt and regular materials can be transported to the gas stage.

This paper deals with the survey on various papers based on the (i) landfill leachate layer and other aspects such as base layer, thermal properties, treatments, clogging, etc. of landfills are discussed(ii)Recycled Coarse Aggregate's (RAC) behavior and characteristics. The paper discusses numerous approaches for concentrating on the features of RAC and landfills.

Typical Anatomy of a Landfill

Landfill have four critical elements namely (i) a bottom liner (ii) a leachate collection system (iii) a cover, and (iv) the natural hydrogeologic setting. The normal setting can be chosen to limit the chance of squanders getting away to groundwater underneath a landfill. The anatomy of landfill is shown in the fig.1.

Leachates, or seeping liquid, are in the upper layer. These are dissolved and suspended from the landfill. The sewer water plant's piping system is used for treatment and sanitation. To prepare a landfill site, undesired stuff is usually removed. In order to prevent soil and groundwater contamination, soil is also compacted. The polyethylene lining prevents dirt and groundwater from condensing or reaching strong waste. This liner is cut-safe HDPE. The next layer contains gravel. As an absorbent substrate, it helps landfill leachate seep into the framework. Fifth layer, a fine texture, prevents leachate collection framework clogging. Active or closed landfill cells generate methane and other gases as garbage separates. Since this gas can burn or explode, it's removed through a series of pipes. When a landfill segment is full, it is sealed and permanently covered with compacted dirt, polyethylene plastic, and topsoil that will be seeded to stimulate plant growth

 https://doi.org/10.37896/pd91.5/9159

ISSN: 0369-8963

and prevent deterioration. These wells are used to collect and test groundwater for leachate. Most dumps are used for athletics. Sporting applications include fairways, natural areas, fields, and walking paths. Because trash disintegration does not negatively affect sporting offices, these improvements are easy to build and maintain.

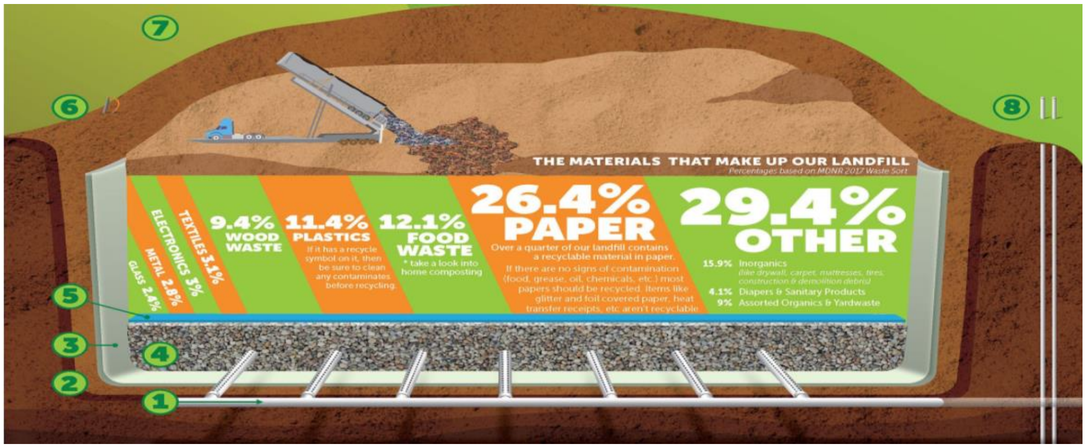

Fig.2: Anatomy of landfill adapted from springfieldmo.gov

Significance of Landfill Base Layer

Ordinarily, "landfill" means sterile landfill. These facilities were established in the 1960s to eliminate open landfills and other "unhygienic" waste management practices. The clean landfill is a purpose-built waste control facility. In clean landfills, microbes should be able to split complicated natural waste into safer combinations (bioreactors). Planned and operated under administrative rules. Most landfills use high-impact degradation to sort garbage. Then four anaerobic stages. Nature rots swiftly when larger atoms disintegrate into smaller ones. Then the natural particles are hydrolyzed, which intensifies and then changes and volatilizes as CO_2 and CH_4, with the residual waste surplus in the strong and fluid phases. Meanwhile, the leachate's COD rises when aggressive mixtures contrast with more responsive ones. The ability of microbial populations to syntrophy, or cater for each other's needs, is crucial for waste transformation and adjustment.

Concerns In Landfill

When landfill is considered, there are lots of concerns such as clogging, seepage, drainage, etc. which are discussed below. These problems can also be analyzed using numerical analysis method by installing cooling pipes to reduce the temperature R. Kerry Rowe et al. (2010) [51] assessed the heat generated by the structure with and without horizontal cooling pipes. A cooling system decreases waste heat and extends liner component life, according to the study. 9 m split cooling system enhanced life from 85 to 175-565 years. Tara Ramani (2012) [46] examined Landfill gas (LFG) in Mumbai, India. Preliminary studies suggest LFGTE projects can yield economic rewards. Jason L. Coo, et.al. (2017) [16] modelled the infiltration in a three-layer landfill cover. Clay surrounded the capillary barrier. A tensiometer and a single-layered soil slice were used. Three-layer landfill cover architecture works in moist settings. Michael J. Burlingame et al. (2006) [14] studied slope stability during landfill closure design. Limit equilibrium research became numerical modelling. The study found that processing time is significant and software must be user-friendly. Sohail Ayub and Afzal Husain Khan (2011) [66] had highlighted about the usage of landfill practices in India and the safe control and usage of landfill gas. over the

 https://doi.org/10.37896/pd91.5/9159

ISSN: 0369-8963

studies it was made clear the many landfills in India are prone to toxication the soil and groundwater due to the release of toxic leachates that are produced from the landfill wastes.

Clogging in landfill

R. Kerry Rowe (2013) [50], et.al. studied leachate characterization and clogging with mesocosms in a municipal solid waste landfill. Experiments with 38 mm and 19 mm gravel indicated that the model predicted COD and calcium levels well. William Craven (1999) [17] created a leachate collection method for solid waste dumps. Clogging must be treated to avoid failure. To prevent blockage, the physical and chemical drainage flow were studied. The experiments showed a drop in permeability and permittivity in both the sand and geotextile situations. Stanislaw Lozecznik and Jamie Van Gulck (2009) [32] employed high-density polyethylene pipes with 0.05 and 0.1 m external diameters and 0.04 and 0.08 m inner diameters to study clogging in warmed landfill pipelines. The blocking material was 40-45% volatile and inorganic after 5 months. 0.08-m pipes clogged more than 0.04-m pipes. Smaller diameter pipes lose hydraulic performance faster than bigger ones. R. Kerry Rowe and Reagan McIsaac (2005) [49] studied 100 mm x 350 mm x 310 mm and 125 mmx340 mmx310 mm tire shreds with 38 mm gravel. Rowe and McIsaac observed. In noncritical zones, a thicker layer of compressed tire shred may offer the same service life as gravel. Reagan McIsaac et al. (2007) [34] studied gravel sizes of 38 mm and 19 mm in leachate collection cells. The gravel investigation lasted a decade. 38mm gravel cell outperformed 19mm gravel cell in tests.

Rigidity in Concrete Liner in landfill

Eshmaiel Ganjian.et.al, (2004) [25] had investigated in alternative technology with low-cost concrete liner. On the other hand, the paper discusses the features of cementious mixes necessary with various ashes. The study showed that while some materials are unsuitable, the majority have adequate qualities and can be used as a layer in landfills.

Drainage in landfill

Shabbir Ahmed (1992) [3] et.al, had developed a numerical model to estimate the time variation of leachate flowing in landfill. using the finite difference scheme in the vertical plane the boundary conditions are calculated. It included various aspects such as runoff, evapotranspiration and infiltration. It was estimated that the downward leachate flow helps to develop the leachate mound at the bottom of the landfill and the vertical flow in the bottom layer was computed using Darcy’s law. Bruce M. McEnroe (1989) [33] devised a systematic solution for steady drainage on impervious layers, based on three-dimensional parameters and saturated depth. The study concluded that a zero-penetration depth or a horizontal phreatic surface can meet the no-flow criteria at the upstream boundary.

Groundwater in landfill

K. O. Ansah Amano et al. (2021) [6] studied 1.34 km of ground water around the landfill. Studying heavy metal concentrations and physicochemical qualities. Water quality was assessed using samples. 83% of hand dug wells, 50% of streams, and 33% of boreholes were turbid. Also mentioned: WQI, HPI, and PCA. 25% of water sources are outstanding, 50% are decent, 15% are awful, and 5% are harmful to drink. Over 100 implies heavy metal pollution in drinking water. According to PCA, the physicochemical and heavy metal parameter variances are 75.30% and 70.88%. All water sources are inappropriate for human consumption (0.0122-0.1090 mg/L >0.003 mg/L). B. P. Naveen, et.al (2018) [37] observed ground water contamination from landfill leachate.

The dump's leachate and surrounding water are unsafe for human consumption. Leaks were sealed with new liners or cement grouts. Grzegorz Przydatek and Wodzimierz Kanownik (2019) [42] researched a landfill's groundwater for seven years. During landfill construction and closure, groundwater and leachate samples were collected quarterly. Higher Cd, EC, and TOC concentrations predicted poor groundwater quality below landfills. Daniel Abiriga and colleagues (2020) [2] studied landfill water contamination. Twenty-four years were spent monitoring a polluted aquifer. Age of trash determined groundwater pollution. Pollutant levels approach the reference value annually. The dump cap reduced groundwater pollution; the study found (P b 0.05). Raj Kumar Singh (2013), et.al.[54] examined leachate's impact on groundwater. The ground water contamination hazard rating system (HARAS) was used on 11 Indian and European landfills. Compared to European landfills, Delhi, Chennai, Ahmedabad, and Kolkata had a greater risk of poisoning ground water. Magda M. Abd El-Salam and Gaber I. Abu-Zuid (2015) [1] studied leachate's impact on groundwater. Other studies examined landfill leachate and groundwater. Leachate comprised organics, salts, and heavy metals, according to physicochemical tests. Biodegradable but unsterilized leachate (0.69). Study results suggest monitoring anaerobic biodegradation for groundwater and leachate remediation.

Performance of Different layers in landfill

Kristina Baziene and Rasa Vaikunaite (2016) [10] examined four different diameter columns to reduce tire shred congestion in landfills. The study found that tire shreds provided high porosity and drainage in landfills. Charles W.W. Ng, et al. (2016) [38] presented a three-layer landfill cover system. The experiment assessed water infiltration in the soil column over 48 hours and for decades. Damp locations need bottom clay, according to the study. Al-Tabbaa and Aravinthan (1998) [5] studied clay mixed with shredded tire as a landfill liner. Evaluated many aspects. The lighter tire reduces dry density, permeability drops 50 times compared to water, and clay swells more with shredded tires than without. C. T. Nhan et al. (1996) [39] evaluated the hydraulic and chemical barrier properties of coal fly ash, lime dust, and bentonite. The investigation found that water is hydraulically conductive while leachate is chemically barrier-like. Coal fly ash protects MSW dumps from chemicals. Joseph Scalia et al. (2011) [52] studied the hydraulic conductivity of geosynthetic clay liners excavated from composite barriers. (Standard water and type II deionize water). The pore water content and particle size distribution of subgrade soils were investigated. According to the study, the last GCL layer percolates less than 4 mm/year in continental climates and almost nothing in semi-arid and arid climates.

William H. Albright et al. (2013) [4] studied composite landfill barriers in the US. Each cover's water balance was determined with a drainage lysimeter, excluding annual percolation. All sites had a high-water-storage soil layer, percolation tests showed. In-service estimates were substantially closer to as-built projections than as-built estimates in water balance calculations. Gregory M. Smith and Ronald E. Rager (2002) [55] devised a Frost-Resistant Landfill Cover Layer. The protective layer's base is the landfill's lifespan. This technology makes radon and penetration barriers last 200 years. In addition to soil constraints, 30 years of daily minimum temperature data are utilized to assess ice depth. They're used to forecast ice depths for repeated periods beyond the record of observable data. Krishna R. Reddy et al. (2010) [47] studied shredded tires as landfill cover. Tire shreds were utilized in lab research to test long-term transmissivity, clogging potential, and interface shear strengths. Shredded tires drain well, according to the study. Shredded tires are a cost-effective way to recycle tires and cover abandoned landfills. Shi-Jin Feng et al.(2020) [23] proposed an analytic model for multicomponent landfill gas movement. Layer thickness and pressure contrast were studied. CAA reduces CH4 emissions. Immersion boosts CH4 emission. CH4 emissions regulated top-layer dispersal and weather shift. Bio cover reduces CH4 more than capillary layer thickness.

Seepage in landfill

Qiyong Xu, et al. (2013) [61] conducted research on feasible approaches to control leachate seepage at MSW dump side slopes. This includes limiting liquid volume to avoid seepage, as well as limiting design and operational factors that increase leakage. For bioreactor landfills, decreasing soil permeability and increasing setback distances control leachate seepage.

Settlement in landfill

Ertan Durmusoglu, et al. (2006) [21] used a one-dimensional model and numerical tests to investigate landfill settlement in saturated and unsaturated landfills. In unsaturated conditions, microbial activity creates a gas mixture of methane and carbon dioxide. A saturated landfill settles due to trash weight, while an unsaturated landfill settles due to mass loss due to waste decomposition.

Temperature condition in landfill

Abdelmalek Bouazza et al. [13] measured the cell's temperature (2011). We considered 20-month average waste cell temperature. Two weeks of warming then cooling. The landfill cell's base reached 60°C within the first eight months of inspection. After 13 months, the temperature was 55°C. This means evaluating any impact on cell temperature variations. Temperature affects liner component life, according to A. Hoor and R. K. Rowe (2011) [27]. Between liner layers, the paper uses shredded tire and EPS. This increased secondary geomembrane's lifespan. Leachate openness affects PGM and SGM longevity by 45–100 years. It has a 370–2000-year SGM service life. 360kPa compression thickness. The secondary liner's 1.75m of geofoam lowers heat. Ben Othmen and Bouassida (2013) [11] tested a geomembrane liner barrier using electrical circuits. Leaky landfill barriers shorten the dump's life. Electrical circuits were recommended as a unique, active, and cost-effective solution. G.R.Koerner and R.M. Koernerv (2006) [29] employed geomembranes in dry and wet landfills. The landfill is divided by cells. "Dry" landfill is one cell. Dampness plagues the other cubicle. The dry cell temperature climbed to 30°C after 5.5 years at 20°C. In 3.7 hours, the wet cell temperature rose from 25 to 41-46°C. All cases included data, sizes, and wet/dry cell exams. James L. Hanson et al. (2010) [26] evaluated long- and short-term temperature variations in BC, MI, AK, and NM. Anaerobic and aerobic decomposition increased temperatures. Insulation affects temperature, heat uptake, and heat generated.

Influence of Transportation in landfill

Andrea Dominijanni and Mario Manassero (2008) [19] had investigated based on the behavior of geosynthetic clay liner and compacted clay liner of landfill bottom liner, the advective-diffusive transport hypothesis was developed. The behavior of GCL and CCL membranes was compared. Membrane behavior can affect GCL and CCL performance. Because of this, focusing on GCL performance without considering membrane behavior may lead to inaccurate assumptions about GCL's ability to containment. In 2012 Min-Gyun Park, et al. [41] has used bench scale testing of VOCs to investigate the estimates of volatile organic compound (VOC) transit in composite liners. A semi-analytical and a finite difference model were used to predict the clay and geomembrane liners. The findings of the experiment demonstrated that both models' projections for 400 days were identical.

 https://doi.org/10.37896/pd91.5/9159

Leachate Treatment in landfill

Amin Mojiri et.al. (2020),[36] examined landfill leachate treatment under different conditions. Comparing biological and physiochemical treatments, biological therapies performed better. Mir Amir Mohammad Reshadi (2020) [48] reviewed leachate adsorbents. Magnetic adsorbents have good stability, high adsorption capacities, and excellent recycling and reuse capabilities compared to traditional sorbents. Yanqiu Wang (2020) [2020] addressed the problems created by Fe, activated carbon in leachates. The electron-Fenton reaction is a low-cost process with masses of supply material, according to experiments. K.Y. Foo (2009) [24] examined leachate treatment technologies that prevent landfill leachate from percolating into groundwater and aquifers. Activated carbon controls severe problems in landfill leachates. Adrian. O. Eberemu, et.al (2014) [22] evaluated the performance of bagasse ash treatment of compacted lateritic soil as a garbage landfill barrier. Hydraulic conductivity was measured using a 12 percent bagasse ash soil. Bagasse ash was treated to reduce hydraulic conductivity. Hydraulic conductivity is tested. Safaa M. Raghab et al. (2013) [44] examined aerobic leachate treatment with Alum and accelerators. Perlite/Bentonite Perlite effluent reduces turbidity, conductivity, TDS, BOD, and COD better than Bentonite. Perlite cleared conductivity, turbidity, BOD, and COD at 40 mg/l. Bentonite got 83.5 to 85.0 percent clearance. Eyad S. Batarseh, et.al (2007) [9] studied mature landfill leachates. Ferreting leachate removed natural nonbiodegradables. The highest natural ejection was from 20- and 12-year-old strong waste cells. Ferrate and Fenton's reagent prefer pH 3-5. Both treatments raised carbon commitment.

Mustafa Turan et al. (2005) [58] researched treating sterile landfill leachate with a combination anaerobic fluidized bed and zeolite fixed bed construction. Fluidized bed reactor passed anaerobic test. After 80 days, COD evacuation was 90%, with 18 g COD/L/Day natural stacking. COD was reduced by 0.53 L/g biogas and 75% methane CH4. An anaerobic landfill leachate reactor using zeolite. S.90% of recovered zeolites outperformed untreated Anaerobic and adsorption systems remove COD and alkali from leachate. Deborah R. Birchler et al. (1994) [12] studied leachate evaporation. Distillation investigations employed three mature landfill leachate samples. Single-stage acidic distillation eliminated 95% of ionic contaminants and created no leachate darkening. 85-100% of VOAs were released. Using landfill gas to remove leachate is theoretically conceivable, but controls are needed to modify leachate and methane emission in practice. Sama Azadi et al. (2017) [8] used TiO2 nanoparticles to detoxify landfill leachate. Tungsten-doped TiO2 nanoparticles remediate landfill leachate. Doped TiO2 nanoparticles were used to explore four photocatalytic boundaries. Eight relapse situations were studied to make the model researchable. COD evacuation productivity is 46% in ideal conditions.

Based on the journals that are referred it can be concluded that the liner is one of the important layers in landfill as it keeps the layer from mixing and seeping through the ground. Few improvements in the liners are also mentioned above. The liner helps in trapping the leachate or any other waste water or material that can possibility contaminate the ground water and soil. The temperature and the amount of waste that is collected in the landfill also plays an important role in liners of landfill. With the various liners already introduced and keeping in mind the economical ways Recycled Aggregate can also be used as a liner that can possibly act as a layer that prevents the passage of water or contaminates to the ground. The use of RAC can also be economical and environmentally friendly as it reduces the risk of construction wastes that are accumulated here and there.

Recycled Coarse Aggregate

Concrete recycling is the collection and reuse of demolished concrete structures. Recycling is cheaper and better for the environment than landfilling. Used as street rock, revetments, holding dividers, arranging rock, or a natural component in new concrete. Large portions can be used as blocks or chunks, or connected with new cement to form urbanite buildings. Urbanite (large rubble fragments) can be reused in portions or blocks. The components can be molded, for example using an etch.

RAC in landfill

Haitham Shaheen (2019) [53] developed a landfill with RAC instead of natural aggregate and tested leachate collection. The possibility of employing natural and RAC in landfill was determined using chemical experiments. P. A. Claisse et al. (2003) [15] studied the characteristics of recycled material in concrete barriers in landfills. First-deposit landfills with short functioning lives contain leachate equilibrium. Long-term landfill use disperses diffusion and pressure-driven flow. As cementious components, soda slag, borax slag, and other slags and ashes are mixed with water and recycled lead-acid battery sodium sulphate. NaOH neutralizes acid. Lab and field tests determine the material's durability. Three one-meter-deep field tests use small inverted pyramid waste cells. Each cell received 22 m3 of two-layer concrete. Durability is dictated by the concrete field's function, and concretes can be utilized as landfill barriers due to the wide range of industrial byproducts accessible.

Characteristics feature of RAC

Zhao Zhihui et al. (2013) [65] studied recycling aggregate to alleviate shortage and pollution. Impregnating recyclable material improved performance. 0.8 cement RAC did better. High water-to-cement ratio increased compressive strength. RAC alteration reduces sulphate resistance. Yijin Li et al. (2010) [30] replaced cement-stabilized recycled aggregate with 30% to 100%. We saw compaction, unconfined compressive strength, and dry shrinkage. As RA % increases, so do moisture content and dry density. High-grade road cement dosage is 5%. Jian Yin, et.al. (2010) [62] researched recycled concrete using mineral admixtures. Fly ash and slag boost RAC's workability and reduce its density. After three days, natural and recycled aggregate concrete have equal compressive and tensile strengths. Recycled aggregate was found to work. T.Du et al. (2010) [20] examined high-performance recycled aggregate concrete's strength and microhardness. Recycled aggregate has a higher microhardness than new mortar matrix. ITZ performance increased with RAC minerals. RAC exploits natural aggregate concrete's variation principles. Reema et al. (2020) [18] partially recycled coarse aggregate with building trash. The experiment tested concrete's workability, compressive strength, and split tensile strength. Recycling coarse aggregate improves water absorption, impact value, and bulk density. Khaled Sobhan and Rymond J Krizek (1999) [56] studied fiber-reinforced recycled aggregate with low Portland cement and fly ash percentages. The purpose was to see how much a small amount of fiber reinforcement (4 percent dry weight) may improve flexural fatigue behavior. A normalized base course material consisting mostly of recycled aggregate with just 4% cement and 4% fly ash possesses fatigue strength and endurance limits comparable to most normalized highway materials. Claudio J Zega et al. (2020) [63] studied recycled aggregate in a tough climate. This study examines chloride and sulphate penetration, freezing, and thawing. Because each experience is unique, RA perviousness does not reduce resilience. Recent studies demonstrate 75-100% RAC in challenging settings. More study on RAC is needed to increase recycled aggregate content in new concrete, especially in severe environments. As of now, there's no reason to doubt this material's durability. Zhen liu, et.al, (2016) [31] researched geopolymeric recycled aggregate concrete to tackle construction material problems. The water/cement ratio enhances GRAC specimens' compressive strength, Young's modulus, and Poisson's ratio. Fly ash-based geopolymer beats Portland cement when employing the minimal water/cement ratio. Reza Ashtiani et al. (2014) [7] analyzed recycled aggregate performance mechanically. Various states' recycled aggregate systems' properties were researched. The RAC's performance depends on the material chosen, according to the research.

Physical Properties of RAC

Houria Mefteh, et al. (2013) [35] investigated the effect of moisture content on the addition of recycled aggregate to fresh and hardened concrete. Waiting on the project site affects concrete workability in most cases, but not with recycled aggregate. The properties of these three RCA phases were studied in dry, pre-wetting, and saturated circumstances. RCA applied in pre-wetting and saturated surface dry situations promotes concrete workability. Hui Zhao, et.al, (2020) [64] had studied the property of recycled aggregate as road base materials. Natural and recycled aggregates are graded with an upper, median, and lower limit. With 25,50,75 and 100% replacement of natural aggregate, various attributes were observed. Compared to the other two features, the upper limit preparation had good moisture content. Recycled aggregate can improve the road base material's 7-day unconfined compressive strength by a certain percentage.

Pre-Treatment of RAC

Valerie Spaeth and Assia Djerbi Tegguer (2013) [57] examined polymer-treated RAC. The study reduced water absorption and fragmentation. RA characteristics were controlled with polymer solutions. Sodium silicate, octyl triethoxy silane, and sodium silicate resist water. Polymer treatment benefits recycled coarse aggregate. George Rowland Otoko (2014) [40] explored recycled aggregate difficulties. Recycled RCA was compared to ordinary aggregate. The polymer coating made the RCA water-resistant. Vengadesh Marshall Raman and V.Ramasamy (2020) [45]studied RAC concrete treatments. Eco-friendly and cheap treatments are used. Chemical and mechanical grinding, thermal, chemical, and calcium metasilicate slurry, carbonate and wrapping are being studied. All of these treatments increase the physical, mechanical, and sturdiness of untreated recycled aggregate. The investigation found that recycled aggregate has improved characteristics. Revathi Purushothaman et al. (2015) [43] studied RA concrete treatment options. Chemical and mechanical treatments reduce cement on aggregate. Different combinations use natural, recycled, and treated recycled aggregate. The study found that treated aggregate concrete was as strong as natural aggregate concrete. Matthew Upshaw and C.S. Cai (2020) [59] studied recycled aggregate concretes' characteristics, performance, and numerical modelling. Even though recycled aggregate concrete is inferior to natural aggregate concrete, rising environmental concern in the concrete building and demolition industry requires more research. Industrializing recycled aggregate concrete requires numerical models that accurately explain its behavior under stress. Amnon Katz (2004) [28] explored several recycled aggregate treatments. The RA was cleaned using silica fume and ultrasonic. At 7 and 28 days, silica fume improved compressive strength by 30% and 15%. Ultrasonic therapy improved 7%.

 https://doi.org/10.37896/pd91.5/9159

Summary

This paper discusses various components of landfill liners and recycled aggregate. It is clear that using cementious mixes as a layer in a landfill will be cost effective. The leachate collection can be reduced with the use of shredded tire. Numerical and one-dimensional modelling is used to detect the service life of the landfill barrier. Electrical circuits method is more economical compared to other methods to detect the performance of liner barrier. Different layers of liners are introduced by various others and analyzed for performance and concluded that the secondary layer shows good performances overall. When it comes to Recycled Concrete Aggregate (RAC), polymer treatments are recommended to minimize the recycled coarse aggregate's water absorption. The cement layers are cleaned off from the surface of RAC to produce a good material. The use of treated RAC shows almost same strength of natural aggregate. Recycled Concrete Aggregate (RAC) is a material used in highway pavements. RAC has proven to be economical and in reducing the construction waste.

Conclusion

This study highlights significant issues affecting landfill and groundwater serviceability, as well as RAC performance in terms of water absorption, treatment, field use, and field performance. Firstly, when it comes to landfills, more study is done to prevent leachates from seeping into the earth, and other remedies are also highlighted in this document. More research on cooling pipes used to lower landfill's thermal property is also needed. Second, this study shows alternative liners that can be utilized to increase landfill serviceability. More research is needed to prevent water damage. Finally, more landfill liners can be researched. The literature on Recycled Aggregate Concrete (RAC) addresses its longevity. This report examines RAC's performance and resolves several issues. This paper covers a lot of ground besides performance. The literature also shows long-term performance of RAC manufactured with up to 100% fly ash. More investigations on RAC analysis under natural conditions, as well as RCA replacement, are required for more accurate and long-lasting performance. More research is needed on RAC without treatment. Ongoing research on the components produced by replacing RAC with natural aggregate is required. More research on RAC is required to assess its long-term performance. Recycled Concrete Aggregate (RAC) is recent growing material that should be further investigated in more fields such as landfill, construction to allow new sustainable concrete in this environment. As far as the researches it is believed that Recycled Concrete Aggregate (RAC) shows absolute potential that can be used as a material.one such research that was conducted by Zhao Zhihui et al. (2013) [65] studied recycling aggregate to alleviate shortage and pollution. Impregnating recyclable material improved performance. 0.8 cement RAC did better. High water-to-cement ratio increased compressive strength. RAC alteration reduces sulphate resistance. This can be indicated that Recycled Aggregate concrete shows good properties that can be further used for various researches.

Recommendations

Based on a review of the literature, it can be concluded that the usage Recycled Coarse Aggregate (RCA) can reduce the environment pollution and increase the usage of Recycled Coarse Aggregate. RCA are used after the treatment to remove the cementitious particles that are stuck on the surface of the aggregate after crushing down into smaller particle. The treatment is necessary in order to minimize the damage that can be produced as RCA has high absorption characteristics than the regular aggregates. Moreover, further studies related to the use of RCA without treatment should be made in the future. The thickness of the RCA as liner can be determined based on the type of landfill. It is expected that pre-treatment of the RCA will increase the properties and performance of the aggregate. Moreover, it is cost efficient as in case of reusing, transportation and treatment of RCA. However further experimental research is required to quantify the above-mentioned reviews.

References

1. Abd El-Salam, M.M. and Abu-Zuid, G.I., 2015. Impact of landfill leachate on the groundwater quality: A case study in Egypt. *Journal of advanced research*, *6*(4), pp.579-586. http://dx.doi.org/10.1016/j.jare.2014.02.003
2. Abiriga, D., Vestgarden, L.S. and Klempe, H., 2020. Groundwater contamination from a municipal landfill: Effect of age, landfill closure, and season on groundwater chemistry. *Science of the total environment*, *737*, p.140307. https://doi.org/10.1016/j.scitotenv.2020.140307
3. Ahmed, S., Khanbilvardi, R.M., Fillos, J. and Gleason, P.J., 1992. Two-dimensional leachate estimation through landfills. *Journal of Hydraulic engineering*, *118*(2), pp.306-322. https://doi.org/10.1061/(ASCE)0733-9429(1992)118:2(306)
4. Albright, W.H., Benson, C.H. and Apiwantragoon, P., 2013. Field hydrology of landfill final covers with composite barrier layers. *Journal of Geotechnical and Geoenvironmental Engineering*, *139*(1), pp.1-12. https://doi.org/10.1061/(ASCE)GT.1943-5606.0000741
5. Al-Tabbaa, A. and Aravinthan, T., 1998. Natural clay-shredded tire mixtures as landfill barrier materials. *Waste Management*, *18*(1), pp.9-16. https://doi.org/10.1016/S0956-053X(98)00002-6.
6. Amano, K.O.A., Danso-Boateng, E., Adom, E., Kwame Nkansah, D., Amoamah, E.S. and Appiah-Danquah, E., 2021. Effect of waste landfill site on surface and ground water drinking quality. *Water and Environment Journal*, *35*(2), pp.715-729. https://doi.org/10.1111/wej.12664
7. Ashtiani, R., Saeed, A. and Hammons, M., 2014. Mechanistic characterization and performance evaluation of recycled aggregate systems. *Journal of materials in civil engineering*, *26*(1), pp.99-106. https://doi.org/10.1061/(ASCE)MT.1943-5533.0000798
8. Azadi, S., Karimi-Jashni, A. and Javadpour, S., 2017. Photocatalytic treatment of landfill leachate using W-doped TiO 2 nanoparticles. *Journal of Environmental Engineering*, *143*(9), p.04017049. https://doi.org/10.1061/(ASCE)EE.1943-7870.0001244
9. Batarseh, E.S., Reinhart, D.R. and Daly, L., 2007. Liquid sodium ferrate and Fenton's reagent for treatment of mature landfill leachate. *Journal of Environmental Engineering*, *133*(11), pp.1042-1050. https://doi.org/10.1061/(ASCE)0733-9372(2007)133:11(1042)
10. Bazienė, K. and Vaiškūnaitė, R., 2016. Research of sustainable use of tire shreds in landfill. *Sustainability*, *8*(8), p.767. https://doi.org/10.3390/su8080767
11. Ben Othmen, A. and Bouassida, M., 2013. Detecting defects in geomembranes of landfill liner systems: durable electrical method. *International journal of geotechnical engineering*, *7*(2), pp.130-135. https://doi.org/10.1179/1938636213Z.00000000013

ISSN: 0369-8963

12. Birchler, D.R., Milke, M.W., Marks, A.L. and Luthy, R.G., 1994. Landfill leachate treatment by evaporation. *Journal of Environmental Engineering*, *120*(5), pp.1109-1131. https://doi.org/10.1061/(ASCE)0733-9372(1994)120:5(1109)
13. Bouazza, A., Nahlawi, H. and Aylward, M., 2011. In situ temperature monitoring in an organic-waste landfill cell. *Journal of Geotechnical and Geoenvironmental Engineering*, *137*(12), pp.1286-1289. https://doi.org/10.1061/(ASCE)GT.1943-5606.0000533
14. Burlingame, M.J., Fouda, A.M. and Hart, R.D., 2006. Modeling of landfill stability with vertical barrier walls: A practical example using limit equilibrium and numerical methods. In *GeoCongress 2006: Geotechnical Engineering in the Information Technology Age* (pp. 1-6). https://doi.org/10.1061/40803(187)222
15. Claisse, P.A., Atkinson, A., Ganjian, E. and Tyrer, M., 2003, June. Recycled materials in concrete barriers. In *Proceedings of the Sixth Canmet/ACI Conference on the Durability of Concrete, Thessaloniki, Greece* (pp. 951-971).
16. Coo, J.L., So, Z.P. and Ng, C.W., 2017. Physical and Numerical Modeling of an Earthen Three-Layer Landfill Cover System under One-Dimensional Infiltration. In *PanAm Unsaturated Soils 2017* (pp. 247-257). https://doi.org/10.1061/9780784481684.026
17. Craven, W., Townsend, T.G., Vogel, K. and Laux, S., 1999. Field investigation of landfill leachate collection system clogging. *Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management*, *3*(1), pp.2-9. https://doi.org/10.1061/(ASCE)1090-025X(1999)3:1(2)
18. Daniyal, M. and Singh, S.K., Partial Replacement of Coarse Aggregates with Demolition Waste In Construction.
19. Dominijanni, A. and Manassero, M., 2008. Influence of membrane behavior on contaminant transport through geosynthetic clay liners. In *GeoCongress 2008: Characterization, Monitoring, and Modeling of GeoSystems* (pp. 814-821). https://doi.org/10.1061/40972(311)101
20. Du, T., Wang, W.H., Lin, H.L., Liu, Z.X. and Liu, J., 2010. Experimental study on interfacial strength of the high performance recycled aggregate concrete. In *Earth and Space 2010: Engineering, Science, Construction, and Operations in Challenging Environments* (pp. 2821-2828). https://doi.org/10.1061/41096(366)266
21. Durmusoglu, E., Corapcioglu, M.Y. and Tuncay, K., 2006. Modeling of settlement in saturated and unsaturated municipal landfills. *International Journal of Geomechanics*, *6*(4), pp.269-278.
22. Eberemu, A.O., Afolayan, J.O., Abubakar, I. and Osinubi, K.J., 2014. Reliability evaluation of compacted lateritic soil treated with bagasse ash as material for waste landfill barrier. In *Geo-Congress 2014: Geo-characterization and Modeling for Sustainability* (pp. 911-920).
23. Feng, S.J., Zhu, Z.W., Chen, Z.L. and Chen, H.X., 2020. Analytical model for multicomponent landfill gas migration through four-layer landfill biocover with capillary barrier. *International Journal of Geomechanics*, *20*(3), p.04020001. https://doi.org/10.1061/(ASCE)GM.1943-5622.0001598.
24. Foo, K.Y. and Hameed, B.H., 2009. An overview of landfill leachate treatment via activated carbon adsorption process. *Journal of hazardous materials*, *171*(1-3), pp.54-60. https://doi.org/10.1016/j.jhazmat.2009.06.038

25. Ganjian, E., Claisse, P.A., Tyrer, M. and Atkinson, A., 2004. Selection of cementitious mixes as a barrier for landfill leachate containment. *Journal of materials in civil engineering*, *16*(5), pp.477-486. https://doi.org/10.1061/(ASCE)0899-1561(2004)16:5(477)
26. Hanson, J.L., Yesiller, N. and Oettle, N.K., 2010. Spatial and temporal temperature distributions in municipal solid waste landfills. *Journal of Environmental Engineering*, *136*(8), p.804. https://doi.org/10.1061/(ASCE)EE.1943-7870.0000202
27. Hoor, A. and Rowe, R.K., 2011. Application of thermal insulation in landfill liners. In *Geo-Frontiers 2011: Advances in Geotechnical Engineering* (pp. 1034-1044). https://doi.org/10.1061/41165(397)106
28. Katz, A., 2004. Treatments for the improvement of recycled aggregate. *Journal of materials in civil engineering*, *16*(6), pp.597-603.
29. Koerner, G.R. and Koerner, R.M., 2006. Long-term temperature monitoring of geomembranes at dry and wet landfills. *Geotextiles and Geomembranes*, *24*(1), pp.72-77. https://doi.org/10.1016/j.geotexmem.2004.11.003
30. Li, Y., Sun, X. and Yin, J., 2010. Mix design of cement-stabilized recycled aggregate base course material. In *Paving materials and pavement analysis* (pp. 184-192). https://doi.org/10.1061/41104(377)22
31. Liu, Z., Cai, C.S., Peng, H. and Fan, F., 2016. Experimental study of the geopolymeric recycled aggregate concrete. *Journal of Materials in Civil Engineering*, *28*(9), p.04016077. https://doi.org/10.1061/(ASCE)MT.1943-5533.0001584
32. Lozecznik, S. and Van Gulck, J., 2009. Full-scale laboratory study into clogging of pipes permeated with landfill leachate. *Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management*, *13*(4), pp.261-269. https://doi.org/10.1061/(ASCE)1090-025X(2009)13:4(261)
33. McEnroe, B.M., 1989. Steady drainage of landfill covers and bottom liners. *Journal of Environmental Engineering*, *115*(6), pp.1114-1122. https://doi.org/10.1061/(ASCE)0733-9372(1989)115:6(1114)
34. McIsaac, R. and Rowe, R.K., 2007. Clogging of gravel drainage layers permeated with landfill leachate. *Journal of Geotechnical and Geoenvironmental Engineering*, *133*(8), pp.1026-1039. https://doi.org/10.1061/(ASCE)1090-0241(2007)133:8(1026)
35. Mefteh, H., Kebaïli, O., Oucief, H., Berredjem, L. and Arabi, N., 2013. Influence of moisture conditioning of recycled aggregates on the properties of fresh and hardened concrete. *Journal of cleaner production*, *54*, pp.282-288. http://dx.doi.org/10.1016/j.jclepro.2013.05.009
36. Mojiri, A., Zhou, J.L., Ratnaweera, H., Ohashi, A., Ozaki, N., Kindaichi, T. and Asakura, H., 2021. Treatment of landfill leachate with different techniques: an overview. *Journal of Water Reuse and Desalination*, *11*(1), pp.66-96. https://doi.org/10.2166/wrd.2020.079
37. Naveen, B.P., Sumalatha, J. and Malik, R.K., 2018. A study on contamination of ground and surface water bodies by leachate leakage from a landfill in Bangalore, India. *International Journal of Geo-Engineering*, *9*(1), pp.1-20. https://doi.org/10.1186/s40703-018-0095-x
38. Ng, C.W., Coo, J.L., Chen, Z.K. and Chen, R., 2016. Water infiltration into a new three-layer landfill cover system. *Journal of Environmental Engineering*, *142*(5), p.04016007. https://doi.org/10.1061/(ASCE)EE.1943-7870.0001074.

39. Nhan, C.T., Graydon, J.W. and Kirk, D.W., 1996. Utilizing coal fly ash as a landfill barrier material. *Waste Management*, *16*(7), pp.587-595. https://doi.org/10.1016/S0956-053X(96)00108-0
40. Otoko, G.R., 2014. A solution to the problem of recycled concrete aggregates. *International Journal of Engineering and Technology Research*, *2*(4), pp.1-6.
41. Park, M.G., Edil, T.B. and Benson, C.H., 2012. Modeling volatile organic compound transport in composite liners. *Journal of geotechnical and geoenvironmental engineering*, *138*(6), pp.641-657. https://doi.org/10.1061/(ASCE)GT.1943-5606.0000630
42. Przydatek, G. and Kanownik, W., 2019. Impact of small municipal solid waste landfill on groundwater quality. *Environmental Monitoring and Assessment*, *191*(3), pp.1-14. https://doi.org/10.1007/s10661-019-7279-5
43. Purushothaman, R., Amirthavalli, R.R. and Karan, L., 2015. Influence of treatment methods on the strength and performance characteristics of recycled aggregate concrete. *Journal of Materials in Civil Engineering*, *27*(5), p.04014168. https://doi.org/10.1061/(ASCE)MT.1943-5533.0001128
44. Raghab, S.M., Abd El Meguid, A.M. and Hegazi, H.A., 2013. Treatment of leachate from municipal solid waste landfill. *HBRC journal*, *9*(2), pp.187-192. http://dx.doi.org/10.1016/j.hbrcj.2013.05.007
45. Raman, J.V.M. and Ramasamy, V., 2021. Various treatment techniques involved to enhance the recycled coarse aggregate in concrete: A review. *Materials Today: Proceedings*, *45*, pp.6356-6363. https://doi.org/10.1016/j.matpr.2020.10.935
46. Ramani, T., Sprague, S., Zietsman, J., Kumar, S., Kumar, R. and Krishnan, A., 2012. Landfill gas to energy applications in India: prefeasibility analysis of Mumbai landfills. *Journal of Hazardous, Toxic, and Radioactive Waste*, *16*(3), pp.250-257. https://doi.org/10.1061/(ASCE)HZ.2153-5515.0000119
47. Reddy, K.R., Stark, T.D. and Marella, A., 2010. Beneficial use of shredded tires as drainage material in cover systems for abandoned landfills. *Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management*, *14*(1), pp.47-60. https://doi.org/10.1061/(ASCE)1090-025X(2010)14:1(47)
48. Reshadi, M.A.M., Bazargan, A. and McKay, G., 2020. A review of the application of adsorbents for landfill leachate treatment: Focus on magnetic adsorption. *Science of the total environment*, *731*, p.138863. https://doi.org/10.1016/j.scitotenv.2020.138863
49. Rowe, R.K. and McIsaac, R., 2005. Clogging of tire shreds and gravel permeated with landfill leachate. *Journal of Geotechnical and Geoenvironmental Engineering*, *131*(6), pp.682-693. https://doi.org/10.1061/(ASCE)1090-0241(2005)131:6(682)
50. Rowe, R.K. and Yu, Y., 2013. Modeling of leachate characteristics and clogging of gravel drainage mesocosms permeated with landfill leachate. *Journal of geotechnical and geoenvironmental engineering*, *139*(7), pp.1022-1034. https://doi.org/10.1061/(ASCE)GT.1943-5606.0000834
51. Rowe, R.K., Hoor, A. and Pollard, A., 2010. Numerical examination of a method for reducing the temperature of municipal solid waste landfill liners. *Journal of Environmental Engineering*, *136*(8), pp.794-803. https://doi.org/10.1061/(ASCE)EE.1943-7870.0000212
52. Scalia IV, J. and Benson, C.H., 2011. Hydraulic conductivity of geosynthetic clay liners exhumed from landfill final covers with composite barriers. *Journal of Geotechnical and Geoenvironmental Engineering*, *137*(1), pp.1-13.

53. Shaheen, H., Fadel, I. and Dayoub, N., 2019. A comparison of selected parameters of leachate in natural and recycled aggregates used in the design of sanitary landfills.
54. Singh, R.K., Datta, M., Nema, A.K. and Pérez, I.V., 2013. Evaluating groundwater contamination hazard rating of municipal solid waste landfills in India and Europe using a new system. *Journal of Hazardous, Toxic, and Radioactive Waste*, *17*(1), pp.62-73. https://doi.org/10.1061/(ASCE)HZ.2153-5515.0000145
55. Smith, G.M. and Rager, R.E., 2002. Protective layer design in landfill covers based on frost penetration. *Journal of geotechnical and geoenvironmental engineering*, *128*(9), pp.794-799. https://doi.org/10.1061/(ASCE)1090-0241(2002)128:9(794)
56. Sobhan, K. and Krizek, R.J., 1999. Fatigue behavior of fiber-reinforced recycled aggregate base course. *Journal of materials in civil engineering*, *11*(2), pp.124-130. https://doi.org/10.1061/(ASCE)0899-1561(1999)11:2(124)
57. Spaeth, V. and Tegguer, A.D., 2013. Improvement of recycled concrete aggregate properties by polymer treatments. *International Journal of Sustainable Built Environment*, *2*(2), pp.143-152. https://doi.org/10.1016/j.ijsbe.2014.03.003
58. Turan, M., Gulsen, H. and Çelik, M.S., 2005. Treatment of landfill leachate by a combined anaerobic fluidized bed and zeolite column system. *Journal of environmental engineering*, *131*(5), pp.815-819. https://doi.org/10.1061/(ASCE)0733-9372(2005)131:5(815)
59. Upshaw, M. and Cai, C.S., 2020. Critical review of recycled aggregate concrete properties, improvements, and numerical models. *Journal of Materials in Civil Engineering*, *32*(11), p.03120005. https://doi.org/10.1061/(ASCE)MT.1943-5533.0003394
60. Wang, Y., Zhou, C., Meng, G., Bai, J., Geng, X., Yanli, L.V. and Chen, X., 2020. Treatment of landfill leachate membrane filtration concentrate by synergistic effect of electrocatalysis and electro-Fenton. *Journal of Water Process Engineering*, *37,* p.101458. https://doi.org/10.1016/j.jwpe.2020.101458
61. Xu, Q., Powell, J., Tolaymat, T. and Townsend, T.G., 2013. Seepage control strategies at bioreactor landfills. *Journal of Hazardous, Toxic, and Radioactive Waste*, *17*(4), pp.342-350. https://doi.org/10.1061/(ASCE)HZ.2153-5515.0000185
62. Yin, J., Chi, Y., Gong, S. and Zou, W., 2010. Research and application of recycled aggregate concrete. In *Paving Materials and Pavement Analysis* (pp. 162-168). https://doi.org/10.1061/41104(377)19
63. Zega, C.J., Santillán, L., Sosa, M.E. and Villagrán Zaccardi, Y.A., 2020. Durable performance of recycled aggregate concrete in aggressive environments. https://doi.org/10.1061/(ASCE)MT.1943-5533.0003253
64. Zhao, H., Yang, W., Ge, Y., Liu, P. and Zhang, D., 2020. Effect of Recycled Aggregate on the Properties of Road Base Materials. In *ICTE 2019* (pp. 796-802). Reston, VA: American Society of Civil Engineers. https://doi.org/10.1061/9780784482742.089
65. Zhao, Z., Wang, S., Lu, L. and Gong, C., 2013. Evaluation of pre-coated recycled aggregate for concrete and mortar. *Construction and Building Materials*, *43*, pp.191-196. https://doi.org/10.1016/j.conbuildmat.2013.01.032
66. Ayub, S. and Khan, A.H., 2011. Landfill practice in India: A review. *Journal of Chemical and Pharmaceutical Research*, *3*(4), pp.270-279.