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Review on Impact of Construction Waste Landfill on Environment and its Reutilization

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ABSTRACT

In several countries, the use of recycled coarse aggregate in construction materials is recommended; however, the use of organic matter is restricted because it can produce significant changes in compressive strength. In terms of reaching a conclusive viewpoint regarding the research topic, secondary data collection analysis has been selected. It is essential to utilize the recycled and by-products wastages to prepare alternative materials as this can be useful in generating a significant amount of fine concrete aggregate. As a result, it reduces the extreme exploration of essential natural resources and meets the requirements of natural concrete aggregates by using the alternative and recycled fine concrete aggregate. Moreover, the alternative materials come with similar properties and physical behaviour as they sustain the durability and compound stability of the concrete aggregate through the use of recycled cement. The disposal of industrial wastes can cause extreme environmental harm that can be reduced via recycled cement. However, it has been noted that the presence of harmful materials can result in issues regarding durability. Thus, it is essential to arrange materials for recycled cement that can be effective for construction activities. In order to maintain environmental sustainability and reduce environmental hazards, it is important to utilize the wastages for generating alternative concrete aggregates such as crushed rocks. Thus, this paper reviews the environmental effects of concrete waste pollutants and its sustainable reutilization to promote a cleaner environment and offer benefits to the construction industries with a positive effect.

Keywords: infrastructure development, concrete waste pollutant, environmental hazard, alternative material, cleaner environment.

INTRODUCTION

In this recent decade, within this rapidly growing improvement, most infrastructures are built with concrete. The mechanical and durability properties of concrete depend on the mix proportion of concrete. Concrete is a flexible construction material with great demand as it is a composite material. Different natural coarse aggregates help to create effective strengths regarding concrete production. The massive usage of concrete and generation of industrial waste by demolition leads to a lack of raw material availability. The increasing chances of resource depletion and lack of presence of sustainable sources create a scenario for the usage of fine recycled aggregate concrete (Khatib 2014). Moreover, due to old attached cement mortal, the lower strength of water absorption negatively affects the durability and mechanical properties of fresh and hardened concrete. The factor of concern to concrete's durability properties needs a harsh environment usage. (Leite and Santana 2019) mentioned that if opposed to using non-renewable mineral wealth, the exact usage of building plastic waste as aggregates for production is particularly appealing since it promotes environmental conservation (Figure 1).

The usage of recycled coarse aggregate in construction material is recommended in several nations; however, the usage of organic matter is restricted since it may cause considerable changes in compressive strength. In the recent decade, the usage of recycled fine aggregates has attracted international interest owing to the

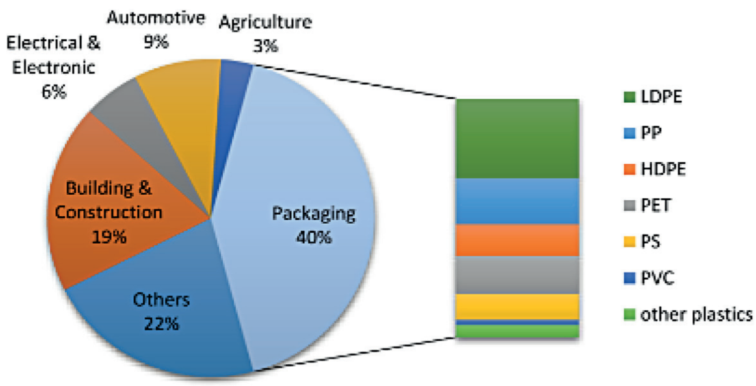

Figure 1. Materials that directly affects human body (Leite and Santana, 2019)

economic, financial impacts of a lack of natural sands. The waste or recycling economy has considerable safety problems such as chemical exposure, flammable dust explosion, equipment monitoring, and heavy machinery exposure (Figure 2) (Nedeljković et al. 2021). Another concern with recycling facilities is their high volume-to-weight ratio, making collecting and distribution prohibitively expensive. Concrete is the most common element to use as a supportive tool in man-made construction activities (Costa et al. 2020). This report discusses on the increase in the generation of construction debris through demolition and renovation of existing infrastructures. The reuse of recycled raw materials is one of the mitigating strategies that most building construction has adopted (Sim and Park, 2021). This paper will reveal that manufacturing natural, and recycled

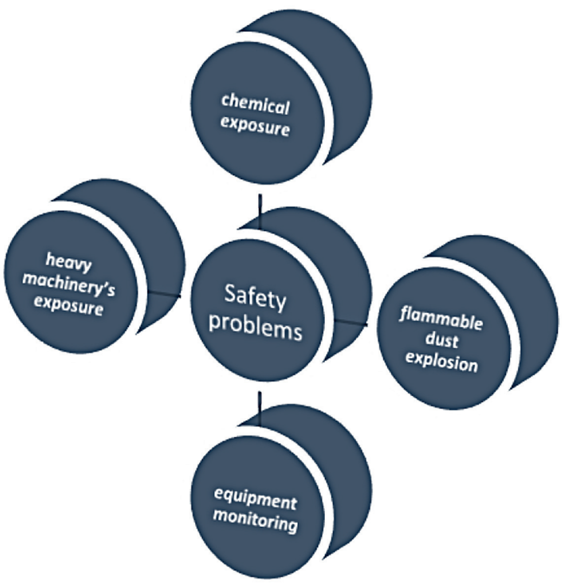

Figure 2. Considerable safety problems (Nedeljković et al. 2021)

concrete aggregate has a net economic benefit as this process is less expensive to produce natural aggregates. The lengthy cost of generating one ton of rough concrete was around 40% cheaper than coarse natural aggregate. Furthermore, generating each ton of concrete has 97 percent better economic impact than conventional concrete. As a result, the commercial manufacturing of supplementary contentious materials from concrete production should be considered an expensive and ecologically friendly construction method.

REQUIREMENT FOR ALTERNATIVE FINE RECYCLED CONCRETE AGGREGATE

Agricultural wastes used as a fine aggregate replacement in concrete are sugarcane biogases ash, groundnut shell, oyster shell, sawdust, giant reed ash, rice husk ash, cork, and tobacco waste. Similarly, recycling and use of construction waste as substitute for aggregates has reached its attention in recent times (Kirthika et al. 2020). Several biomass energies have been used as substitute for cement, a considerable portion, fine aggregates, and reinforcement components in concrete (Górak et al. 2021). However, an assessment integrating numerous factors is required to determine if recycled aggregate concrete production should be prioritized over normal aggregate concrete production. The practice of reusing conventional materials to make aggregates is widely acknowledged as a better option rather to dump and is beneficial to natural resource conservation.

Natural Sand, as this can be considered a critical component in producing a significant amount of recycled and fine concrete aggregate, can be extracted from various natural resources. Dune Sand, river sand, marine sand, and quarry dust can be considered significant and crucial resources of the natural sand (Rajput, 2018). Due to higher silica, better angularity and binding property, river sand is mainly used as filler material in the concrete production. Perhaps, other resources such as quarry dust, marine sand, and dune sand are not suitable for utilizing in the building constructional owing to its deprived properties. The high percentage of salts and unstable components makes these particles unsuitable for replacement of river sand in construction (Zacharia et al. 2018). Among several materials, Dolomite rock sand is the more suitable for achieving the appropriate concrete extract (Rhishi et al. 2022). Due to the massive and negative impact on the essential and natural resources, the constructional sector effectively reduces dolomite rock and it would lead to natural resource exploration.

The researchers focus on exploring alternative materials instead of natural sand and other resources as alternative aggregates with better concrete properties (Oluwasola et al. 2020). Using alternative materials and recycled fine concrete aggregate can reduce the exploitation of natural resources and promote eco-friendly construction methodologies. The disposal of wastages can be considered as one of the most critical error factors as it would increase the waste generation from 2.59 billion tonnes to 3.4 billion by 2030. Such Insufficient strategies and lands for disposing of the wastages lead to producing alternative concrete aggregate materials with a positive effect (Kirthika et al. 2020, Gedela et al. 2021, Mistry et al. 2020). The surface texture and particle shape influence the properties of freshly mixed concrete compared to the hardened concrete properties. Thus, it is essential to recycle the wastages as it would result in the production of alternative aggregates suitable for construction (Figure 3).

IMPACT OF FINE RECYCLED CONCRETE AGGREGATES

The utilization of recycled concrete aggregate obtained by recycling marble waste reduces the usage of river sand and disposal problems. (Fan et al. 2015) suggested that different kinds of aggregate will produce different impacts to the environment during the process of recycling. The impact of concrete made with recycled foundry sand tend to shown positive impacts on the properties of concrete (Habert et al. 2020). Meanwhile, wastes from industries such as steel slag, fly ash, bagasse ash etc. been used to overcome the handling problems and dumping. Similarly, complete utilization of recycled construction wastes as aggregates up to 100% exhibit a negative influence on the concrete properties, limiting its replacement up to 30% (Khatib 2004, Sim and Park, 2021, Kirthika et al. 2020).

RESURRECT BEHAVIOUR OF DIFFERENT FINE CONCRETE AGGREGATE

Demolition waste operations quickly grow worldwide with a growing population, sustainable growth, and urbanization. The evolution of

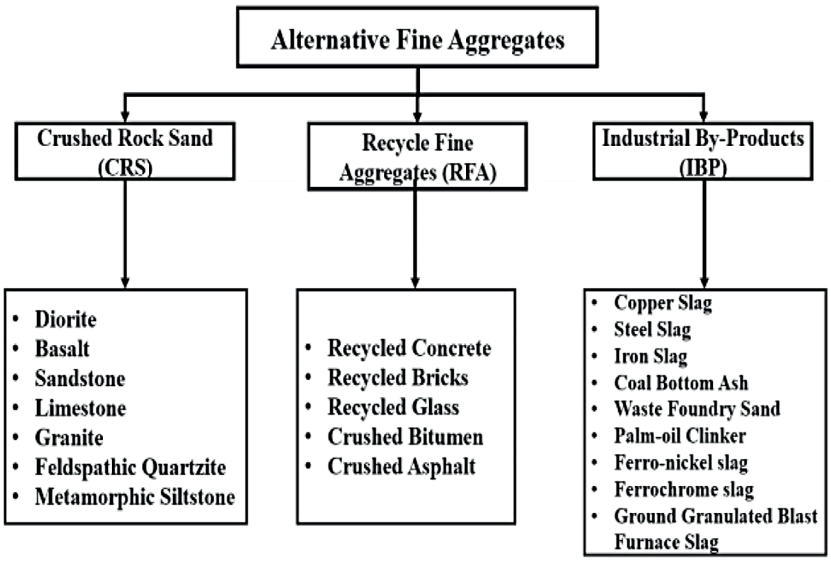

Figure 3. Alternative fine aggregate and its benefits (Kirthika et al. 2020)

the rheological characteristics of concrete with recycled aggregate was negative results due to its higher water absorption characteristics (Oluwasola et al. 2020, Gedela et al. 2021). Proper material requirements also include numerous benefits but many other raw materials such as lithium was not used at significant level to manufacture synthetic concrete mixture. The finer recycled granules resulted in minor improvement in the tensile strength and exhibit higher plasticity index as the rheological properties (Fig. 4) (Guo et al. 2017). The recycled aggregates should be clean, organic and free from lumps to ensure better concrete properties (Saedi et al. 2020).

DURABILITY INCREMENT OF CONCRETE USING FINE RECYCLED CONCRETE AGGREGATES

Even though the building industry is accustomed to using coarse recycled concrete aggregates, concrete mixtures particles are considered to be fewer noble materials. During the selection of aggregates, it is essential to examine their shapes appropriately as it will directly make the concrete piece sustainable. Fine recycled aggregates are considered the last resort in concrete recycling. Their negative impact on the most significant parameters of concrete, such as strength properties, flexural strength, water content, shrinking, acidification, and chlorine absorption, have been reported in several studies (Fig. 5) (Zachariah et al. 2018, Aghabaglou et al. 2015). Generally, recycled concrete has lesser durability than concrete mixture manufactured with native coarse aggregate by 10–25 percent. In most cases, natural sand and gravel are dug from the river or pit or lake as recycled concrete is a viable source of environment. Moreover, keratin, nuclear reactor wastes, concrete block, mining & quarrying waste products, and foundry sand are all considered aggregate in this case.

UTILIZATION OF RECYCLED AGGREGATES IN CONCRETE

Concrete demolition trash has shown to be a great supply of materials for concrete mixes, and many studies have shown that cement built using these fine aggregates could have physical qualities comparable to normal concrete. Perhaps, the fine proportion of these composite materials was not the topic of comprehensive studies since their high-water absorption could imperil the ultimate outcomes (Neno et al. 2014). The angular aggregates are the most demanding particles in the production process of concrete aggregate.

Recycled fine aggregate

The form and texture of aggregates can impact the qualities of fresh concrete and cured concrete. Furthermore, the specific gravity, size grading, moisture levels, and mass bulk density of marble can all impact its strength, longevity, and durability. Cement is easier to deal with when the

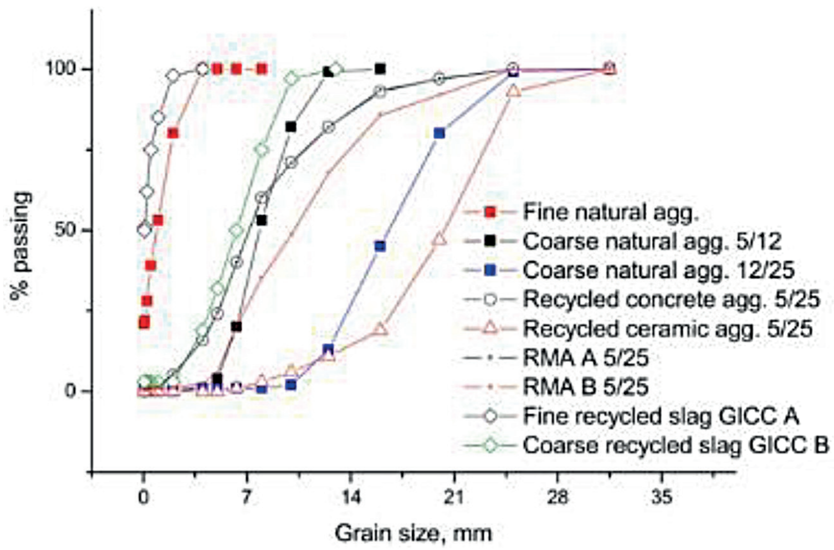

Figure 4. Recycled and natural aggregates (Guo et al. 2017)

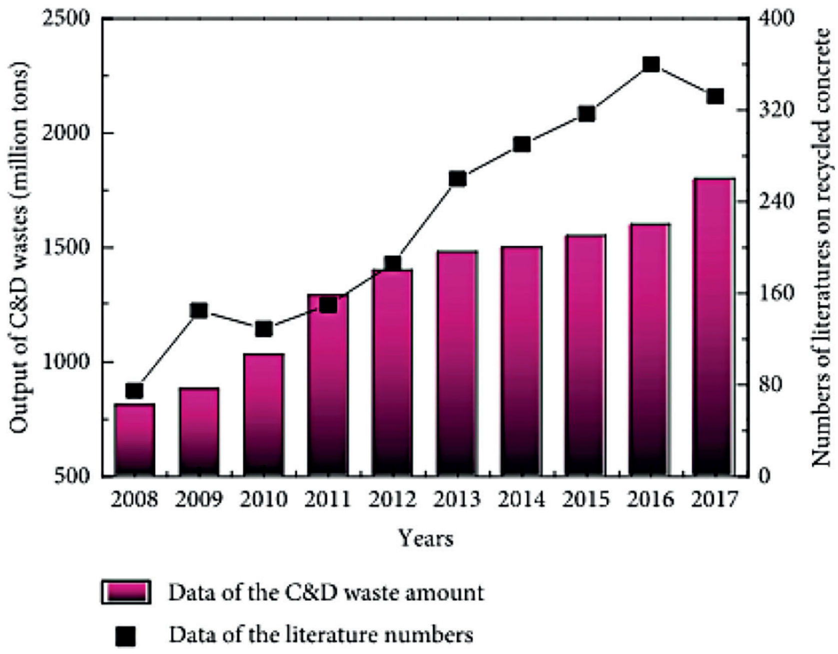

Figure 5. Characteristics of recycled aggregates (Aghabaglou et al., 2015)

grains are clean and rounded. In this case, building construction teams must be well-experienced about their profession as it will be a supportive viewpoint for the alternative fine concrete aggregate. Schoon et al. (2015) observed that many different fine aggregates properties such as shape, size, gravity, surface, index, and water absorption influence the fresh concrete properties such as cohesiveness and workability (Fig. 6).

Kim et al. (2018) reported that recycling concrete wastes to sharp aggregates will lead to difficulty in concrete pumping, and, in this case, workers must be sure about the missing requirements as it will be supportive for the concrete production process. However, recycling to spherical shape may result in flexible pumping and avoid plug jamming. In the construction sites, it is necessary to provide proper supervision

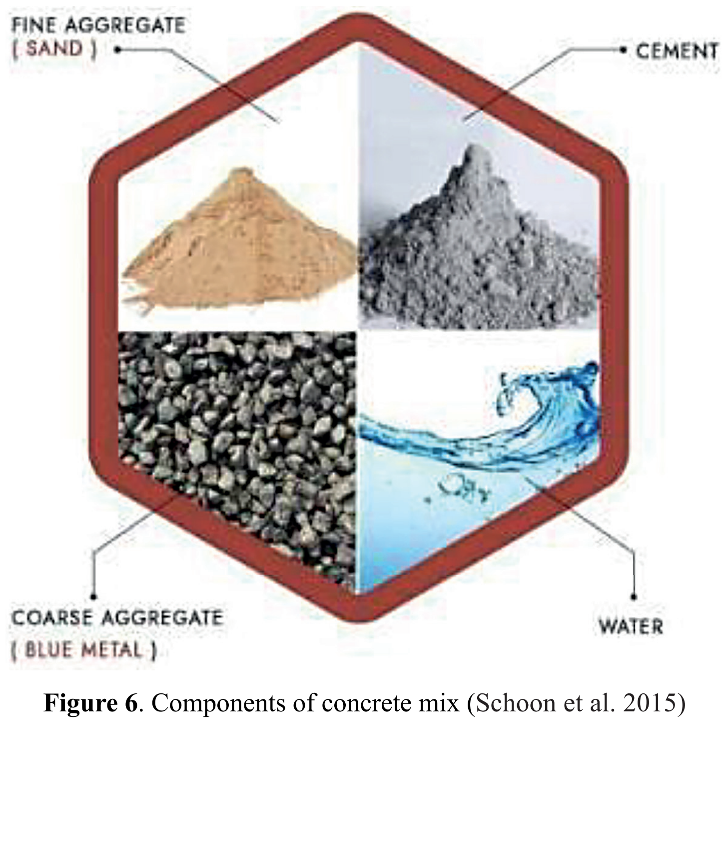

Figure 6. Components of concrete mix (Schoon et al. 2015)

among the production ground to maintain quality and durability, as this positively impacts the industrial and constructional segment.

It is critical to shape the concrete to meet the customers' needs as it will be a great viewpoint for any construction-based organization. The over sanding process is helpful while pumping concrete to improve flow and pressing cement to enable more detail. Saha and Sarker (2017) found that high demands for energy as a result of rapid urbanization and the challenge of disposing of waste material in industrialized countries have provided the potential for agro-waste to be used in building. In order to reduce CO_2, recycled concrete production is recognized as helpful as it supports the sustainability (Krishnan et al. 2021)

The fine proportion of all the composite materials measurement is vital to a proper concrete structure and makes it more durable. According to (Wang et al. 2019), high cement-based mortar, ductility, observation after cement mixing, examining the strength of properties are required to be examined to analyze the proper proportion of concrete production. In order to make the construction process efficient, aggregate is also very critical for concrete's hardness, heat and tensile qualities, and volumetric and stability. Small conventional aggregate materials can prevent red mud, and it has a significant quantity of old contentious matrices. Table 1 shows the usage rate of different forms of crushed sand used as fine aggregates in the concrete.

Utilization of recycled fine aggregate in concrete

Several research have been carried out to investigate the use of recycled fine aggregate as a substitute to natural fine aggregate in concrete. Though fewer complications on its utilization were reported, certain limitations and strategies has imposed its suitability in construction. (Evangelista and de Brito 2007) inferred that the compressive strength of concrete aggregate cannot be affected by utilizing alternative materials' different contents as this maintains the durability of fine recycled concrete aggregate. Furthermore, the removal of fines by several applications can enhance the quality of concrete. (Adnan et al. 2008) replaced NFA with 50% and 100% of RFA and observed that the water absorption characteristics and replacement of RFA impact the durability characteristics of the concrete. However, (Paz et al. 2016) used RFA collected from concrete, ceramics, and the mixture of both as a replacement to NFA and observed that the strength was reduced with 100% of FRA and higher shrinkage values are obtained with an increase in the percentage of RFA.

Ozbakkaloglu et al. (2018) replaced NFA with 25, 50, and 100% of RFA and observed that the optimal replacement was 25% resulting in properties equivalent to conventional concrete. However, replacement beyond 25% affects the properties owing to its higher porosity. (Leite et al. 2019) used two-stage mixing approach technique (TSMA) to prepare the concrete mixture with RFA and inferred that the physical characteristics of RFA such as higher fineness, higher water absorption, rough texture, and irregular shape negatively influence the properties of the concrete. However, the concrete mixtures prepared by TSMA reduce the influence of the above properties as TSMA improves the workability of the concrete. In contrast, Li et al. (2019) replaced NFA with RFA of different particle sizes of 4.75 mm, 2.36 mm, 1.18 mm, 0.6 mm, 0.3 mm, and 0.075 mm and observed maximum reduction in strength and increase in the drying shrinkage with finer fractions of RFA. However, when fine crushed stone (FCS) of the same particle size was

Table 1. Mechanical component usage rate in FRAC (Kim et al. 2018)

Chemical composition (%)	Crushed Sand						
	Granite	Limestone	Basalt	Sandstone	Quartzite	Diorite	Dolomite
SiO_2	55	7	53	80	62	57	1
Al_2O_3	15	2	15	1.5	20	16	-
CaO	1	51	2	-	2	6	32
K_2O	3	0	1	1	-	1	-
Na_2O	3	-	2	1	-	3	-
FeO	0	-	8	0	-	4	0
Fe_2O_3	1	1	6	2	9	2	-

replaced, the properties mentioned above' reduction are less than RFA. The reduction with RFA is due to the old adhered mortar and irregular shape, whereas FCS reduction is due to the irregular shape. Kirthika et al. (2020) RFA collected from the C&D waste plant was used in the percentages of 0, 30, 50, and 100%, and optimal replacement was observed at 100%. Furthermore, with 30% of RFA, the shrinkage and porosity were reduced by 14% and 25%, and chloride resistance was improved by 21.25%. The study inculcated that restriction and limitation towards exploring natural resources lead researchers to utilize alternative materials to produce fine concrete aggregate.

Li et al. (2020) replaced NFA with pre-saturated RFA of the same particle size but with different replacement percentages and observed that the pre-saturation technique tends to reduce the water demand by the RFA during concrete mixing and improved the concrete properties. Zhang et al. (2020) used both finer and coarser fractions of recycled aggregates and observed that the strength was reduced by nearly 45%, and drying shrinkage was increased by 117%. The behaviour of the concrete tends to have less influence with an increase in the percentage of coarse fractions and decreases in the percentage of finer fractions. Salahuddin et al. (2020) collected RFA from two different sources, such as normal strength concrete (NSC) and reactive powder concrete (RPC), and observed a maximum strength of 128 MPa with RPC, and no strength reduction was observed till 50% replacement of RFA. Based on the negative impact of RFA from several studies, Chinzorigta et al. (2020) treated RFA with CO_2 and observed better properties than untreated RFA concrete. Nevertheless, long-term durability properties such as shrinkage, creep, carbonation, and chloride penetration were affected beyond 30% replacement of RFA. Andrade et al. (2020) inferred that durability of fine recycled aggregate concrete increases due to the compressible packing model as the possible application will support lower down usage of natural resources.

Kaarthik et al. (2021) varied the replacement of FRA from 40% to 60% and observed that optimal replacement of RFA was achieved at 60% replacement, beyond which it causes the decrease in the strength of the concrete. Nevertheless at 100% replacement, the compressive strength, tensile strength, and flexural strength were reduced by 16.7%, 35.39%, and 5.48% at 28 days. Saba et al. (2021) used RFA along with masonry cement and observed that RFA does not show any variation in water retentivity due to the viscosity of the alkaline solution. However, the strength was reduced beyond 20% replacement because of the higher porosity of RFA. Similarly, the sorptivity of GP mortars was 2 times lesser than conventional masonry mortars resulting in better durability properties. In contradiction, Huang et al. (2021) used RFA of different particle sizes (4.75 mm, 2.36 mm, 1.18 mm, 0.6 mm, 0.3 mm, and 0.15 mm) on alkali-activated slag cement (AASC) and observed that workability decreases with an increase in the RFA and the strength was also reduced by 10% and 21% with 50% and 100% of RFA. The resistance to carbonation in AASC mixes is more than OPC mixes due to the higher CaO content in RFA results in more $Ca(OH)_2$ to react with CO_2, thus blocking its penetration. Nuaklong et al. (2021) prepared geopolymeric RFA concrete mixes with carbon fibers and observed that optimized mix for better compressive and split tensile strength was prepared with 100% of RFA and 0.2% of CF, whereas for flexural strength, it is observed with 50% of RFA and 0.2% of CF.

In terms of gaining a wide range of benefits in the construction segment, it is essential to use alternative materials and recycled concrete aggregate to produce durable concrete effectively. However, the alternative fine concrete aggregates can meet the requirement of natural sand to maintain durability and stability in particle components.

ELECTROCHEMICAL TECHNIQUES IN FINE RECYCLED CONCRETE AGGREGATE IN CONSTRUCTION SITES

In this current era, significant environmental effect was caused by the manufacturing process of sustainable concrete aggregate. The entire process of making fine concrete aggregates has produced four sets of specimens accompanied by a water-cementitious material rate of 0.48. It has been observed that nearly 35% of replacement level is possible due to help with concrete (Nuaklong et al. 2021). Silva Neto and Leite (2018) oppose that 100% compound portland cement is needed in the series made with natural aggregate. Recycled coarse aggregate (RCA) is an essential requirement in the rising demand for electrochemical techniques to balance the concrete aggregate. Due to multiple suppressed concrete stone chips, developing a mix proportion, concrete's mechanical and durability properties can be adequately balanced (Pareek et al. 2019). The entire process of recycled concrete aggregates focuses on chemical properties, physical properties, engineering properties. Nasiri and Nematzadeh (2017) opined that for each mixture, evaluating corrosion resistance and electrical resistivity, the system of proper proportion of chemicals is highly crucial. The fine concrete aggregates can be completed depending on several essential chemical elements. The addition of SCM has provided knowledge regarding electrochemical techniques in concrete aggregate production.

IMPACT OF SUBSTITUTION OF FINE RECYCLED CONCRETE AGGREGATE IN MECHANISM OF ENVIRONMENT

Over the past decades, recycled concrete aggregate has absorbed 70% of natural resources to balance the autogenous shrinkage across the world. According to Andrade et al. (2020), modifying environmental damage and controlling natural resource waste performance of concrete aggregate is an essential element. Kurda et al. (2017) opined that in concrete production, chemical-mineralogical characterization allows reutilization of the alternative material of environmental resources. Due to industrial production, the requirement of calcium oxide is 0–2 in waste foundry sand and 11–18 in ISF slag, and 0.5–25 in ferronickel slag (Kirthika et al. 2020). Due to various unplanned mining activities, saving natural resources in construction sites, enormous use of concrete has been developed. Though, the process of concrete production includes silica, Portland cement, blast furnace slag, and fly ash, which is employed to replace natural aggregates. The requirement for essential elements to produce new concrete has been extracted from natural resources. Due to having several varieties of alternative raw materials in concrete production, manufacturing new concrete building techniques is concentrated as a crucial requirement.

CONCLUSIONS

It is essential to increase the utilization of alternative materials or recycled concrete aggregates to reduce the exploitation of natural resources effectively. Usage of alternative materials and concrete aggregates and producing concrete elements from wastages or recyclable compounds can have a massive and positive effect in maintaining environmental balance with more efficiency and effectiveness. Moreover, this can be said that utilizing recycled and wastage compounds as alternative materials to generate a significant amount of recycled fine concrete aggregate offers durability, strength performance, mixtures of contents, and another requirement instead of using natural resources. As a result, the alternative concrete aggregates lead towards the segment of maintaining the environmental resource balance effectively and positively. The social and economic cost is too high in managing landfills and waste management. Future researchers can conduct thorough research about the natural resource conservation growth on the usage of fine recycled aggregate concrete. Therefore, it is better to utilize the wastes as these wastages can offer a massive number of alternative compounds that can generate fine concrete aggregate that can positively impact the area of the constructional segment.

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