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ASSESSMENT OF THE PERFORMANCE OF CONCRETE WITH SUSTAINABLE INCORPORATION OF MINE TAILING WASTE AND DOLOMITE WASTE

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Abstract : Mining waste disposal poses a serious environmental issue globally, with waste often dumped openly, leading to pollution, soil contamination, and ecosystem damage. To tackle this, the construction industry is exploring the use of mining waste in concrete production, addressing both waste management and resource scarcity. Concrete's adaptability makes it suitable for incorporating industrial waste, replacing cement and natural river sand.

This study examines zinc tailing waste as a partial cement substitute and dolomite waste as a partial or full river sand replacement, evaluating six concrete mixes with different water-to-cement ratios. Findings show that, while zinc tailing and dolomite waste generally reduce mechanical and durability properties, a mix with 5% zinc tailing and 10% dolomite waste offers comparable performance to standard concrete. This sustainable approach shows potential for cost-effective applications in concrete, paver blocks, and pavements, benefiting both construction and mining industries.

I. INTRODUCTION

1.1 General

General

In recent days, requisition for natural materials in concrete production has increased incredibly due to urbanization and expeditious industrial development. Concrete, the primary structural developing constructional material, consists of cement, sand, and aggregate in different proportions as per design strength requirement (Al-Jabri et al., 2009). Developing country India is the second-largest cement producer after China (Andrew, 2008). In recent years sizably voluminous greenhouse gas emission (mainly CO2 8-9%) and high energy (2-3% annually) required in the production of cement, they are causing severe difficulty on ecology (Imbabi et al., 2012; Oh et al., 2014). The cost of cement and depletion of natural deposits adversely affects the ecology system, directly affecting the economic production of concrete composites. The researchers and industries are fixating on developing sustainable/greener technology to minimize the impact on the circumventing environment (Long et al., 2015; Hemalatha et al., 2016). However, some circumscribed available traditional supplementary cementitious materials and aggregate are available. Therefore, there is a need to found incipient supplementary cementitious material and aggregate that would show kindred or superior interaction with cement in concrete.

The mining industry is one of the most seasoned commercial enterprises worldwide (Kusi-Sarpong, 2016). Nowadays, mining industries generate many types of waste (solid, liquid and gaseous wastes) in large volumes during processing and production; in different categories such as mine waste (low-grade ore, overburden, and barren rocks), tailing waste, dump heap leach and acid mine water (Anju and Banerjee, 2010; Ojuri et al., 2017). The mining process and its waste generation are shown in Fig. 1.1. One of the serious issues in many countries is that it occupies a large land area and cause environmental pollution (Ye et al., 2015).

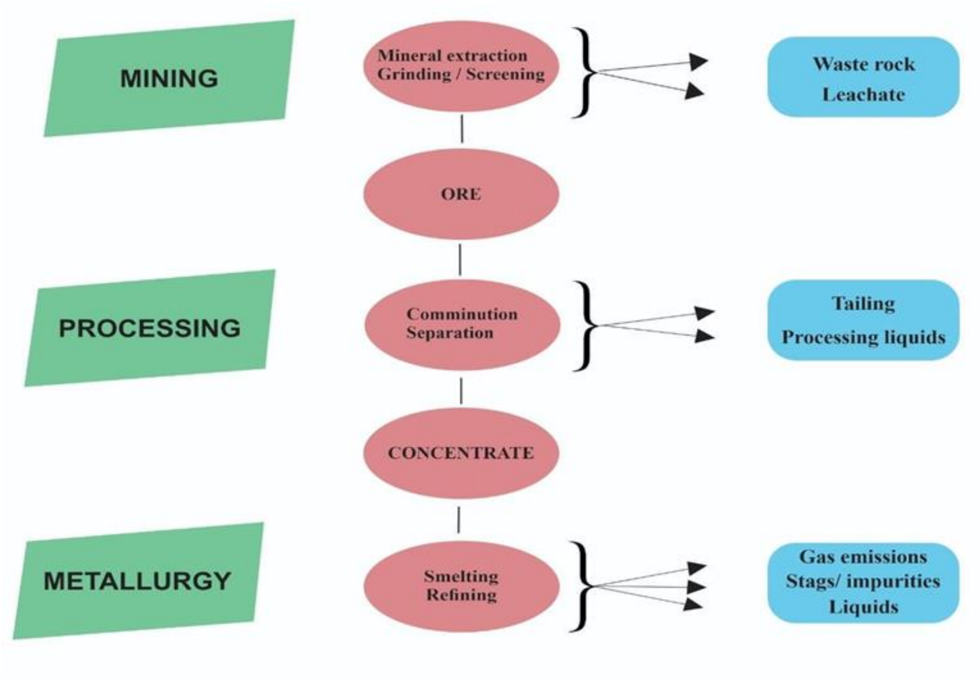


Figure I.1Generation of mining waste

Rajasthan state is rich in minerals, especially in the south-eastern part. The mining activities produce a large amount of waste (such as tailings) through metalliferous mining, which often contains heavy metals in excessive concentrations (Kshirsagar and Aery, 2007). A Zawar mine is one of the oldest Lead-Zinc mine in the world of Hindustan Zinc Limited, Vedanta group, which is situated near to the Udaipur, Rajasthan (Deb and Sarkar, 2017). In Zawar, there are three milling sections (Mochia Mill 2,000 tons/day, Balaria Mill 2,000 tons/day, Old Mill 975tons/day) of different capacity for ore treatment. This ore contains an average of 5% metal (Lead and Zinc) and 95% tailings waste pumped out into the tailing dam (Sekhar and Jakhu, 1983). Every year during production of zinc, tailing waste is generated in the form of slurry. In the past four consecutive years, 2016-17, 2017-18, 2018-19, 2019-20 around 1344164 MT, 1893512 MT, 2720445 MT and 3061474 MT, respectively tailing waste was generated in Zawar mines. Tailing in slurry contains approximately 40% of solid is discharged in the tailing dam (Fig. 1.2). Incorrect waste disposal (Open land) has induced many issues like land degradation, visual effect, loss of aesthetics, air pollution, water pollution etc.

Figure I.2Tailing dam images of Zawar mines

Dolomite, a carbonate material with good weathering resistance, is the type of limestone composed of CaMg(CO3)2 usually available in rock form (Efthimiopoulos et al., 2019). These rocks are crushed in the required size and grade in local mills. In Rajasthan state, there are many dolomite mines; the Rajsamand district belt has a significant deposit of these rocks. In Rajasmand, there are many milling and processing plants in which dolomite is processed. During the processing and crushing into a different size and grade, the many unwanted insignificant aggregates (powders, sands) waste is generated in large amount, having almost the same properties as parent rock (Rana et al., 2016). Waste generation through the dolomite mineral production is shown in Fig. 1.3. The production of dolomite in crushed form leaves a by-product in the open cast mines situated at Amet of Rajsamand district. Dolomite waste quantity is generating very rapidly in the region of Rajasmand district due to the many open cast mines. According to the information published by the Ministry of Mines (India), the dolomite industry annually produced 1.75-2 million tonnes of waste, which is 25% of its production (7-8 million tonnes) material (Indian mineral yearbook-2019, 2020). Fig. 1.4 presents the annual year-wise output of dolomite production in India. These unused by-products or waste, mostly leftovers residue, are dumped at quarries, occupying the large land space and increasing technological costs. These wastes disposed of openly are directly polluting the environment and cause a health hazard, so it requires the approach to recycling the produced waste in a sustainable manner.

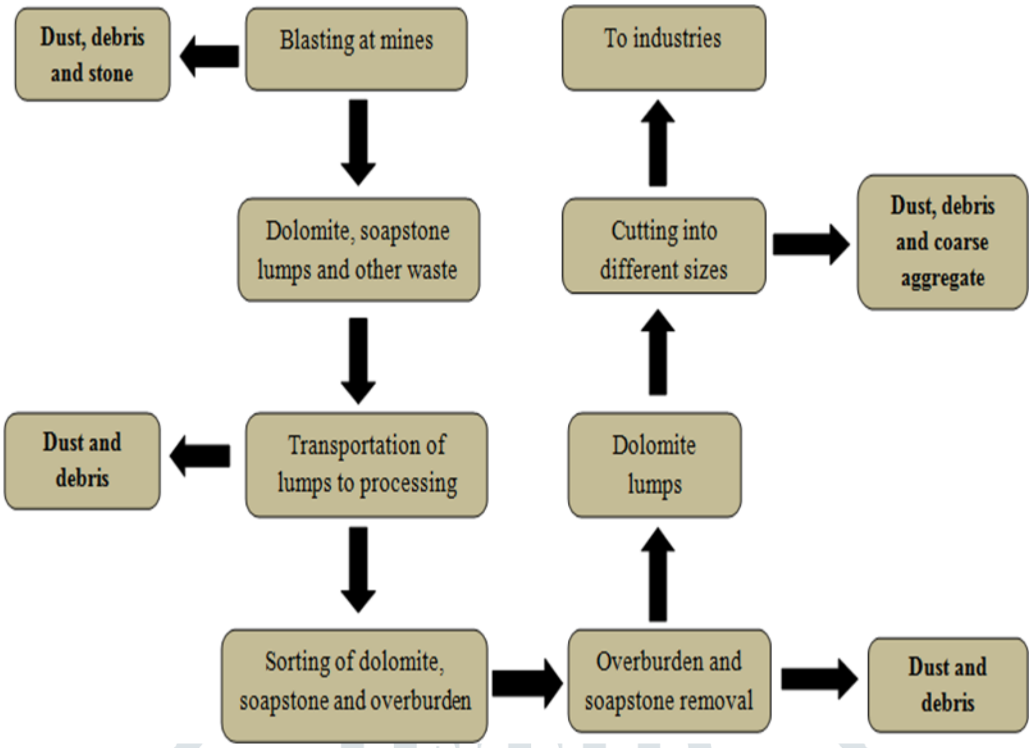
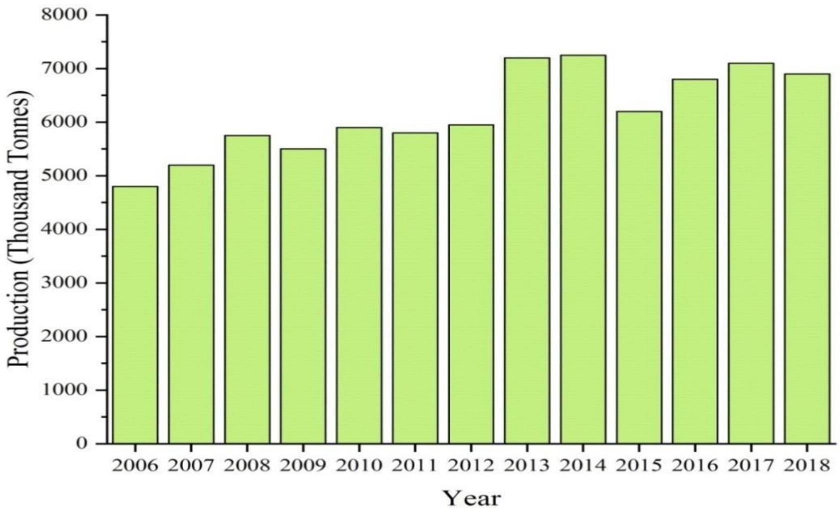


Figure I.3Generation of dolomite waste during quarrying and processing

Today for waste management and sustainable development, this waste should be used to reduce the impact on the environment. The disposal problem of mining waste is a larger issue worldwide, so it must require carrying out some research work on this. Using mine tailing waste and dolomite waste as construction material can provide an efficient way of disposal and reduce environmental pollution. The concrete industry is adversely affected due to the increasing rate and non-availability of material, so we look forward to sustainable development to recycle and reuse industrial mining waste. To avoid the disposals problem and environmental problems caused by the processing of different mining industries, the researchers are doing work to develop effective, unique and cleaner production (Mehra et al., 2016; Taha et al., 2016).



1.2 Significance

Today by virtue of the massive growth and extension of the construction industry, there is a prerequisite for an immense amount of material such as cement and natural aggregate in various construction sites for concrete production. Worldwide, approximately 4-5 billion tons of cement and 15 billion tons of crushed aggregates have been produced annually to manufacture 20 billion tons of concrete (Langer et al., 2004; Shen et al., 2016). Thus manufacturing of cement and aggregate production emits greenhouse gas (33% of total) and consumes energy in an immense amount of approximately about 40% of global energy (Oral and Saygin, 2019). Cement (occupies nearly 10–15% of total concrete volume) greatly influence concrete sustainability and the environment (Dave et al., 2017). The most appropriate way to overcome the environmental impact is to effectively utilize alternative binding material (supplementary cementitious) or industrial waste material in concrete.

Moreover, the stone and mining industries are some of the largest producers of waste in the world. Mining industries produce approximately 20000-25000 million tonnes of overall waste and 5-7 billion tonnes of tailing waste annually worldwide, and this is continuously increasing every year (Lu et al., 2012). The mine tailing wastes are the fine grind slurries residue generated during the processing and extraction of valuable metals (Siddique et al., 2020). Currently, mine tailings are dumped in open land, piles, underwater, ponds, tailing dams, and filled in the mines as backfill (Hudson-Edwards et al., 2011). Globally, the disposal of the mine tailing waste (containing toxic elements) in the open surrounding poses a severe environmental hazard, including dust mobilization in air and water, soil contamination, acidic mine water drainage, and health issues (Perner et al., 2010; Dold, 2014; Panchal et al., 2018). The use of tailing wastes in the concrete as cementitious material will lessen the consumption of the cement since during the manufacturing of the cement massive amount of approximately 7-8% of the total CO2 emits (Chouhan et al., 2017).

On the other hand, the excavation of natural river sand is banned across India by government authorities due to the new environmental policy. The demand for river sand is increasing day by day, affecting the construction industry growth. The depletion of river sand and its non-availability also increases the cost of river sand in recent years. The utilization of the dolomite waste in the production of concrete will reduce the substantial amount of landfills where this waste dumped and provide an alternative source of natural aggregate, which further helps to reduce the demand for natural river sand. Therefore, there is a need to explore industrial waste as an alternative to river sand for economic and sustainable construction practices. In this direction, dolomite waste can be used in concrete as natural river sand.

Worldwide, mining industries generate millions of tons of waste annually; these materials occupy large parts of landfills and withal, causing environmental pollutions (Muduli et al., 2013; Lebre et al., 2017). Lack of space in dense population cities creates the problem of incipient landfills, disposal of wastes, and various pollutions like air, water, and soil (Duan et al., 2019). To overcome these issues, the best solution is to utilize these wastes by using them as supplementary cementations materials, which avail in the conservation of nature's deposits, reduces the landfills spaces, abate the paramount quantity of energy needed for the manufacturing of binding material cement as well as a considerable minimization in CO2 emissions and avail in paramount cost-saving production. In view of the above discussions, it can be summarized that tailing waste and dolomite waste can be utilized to produce modified concrete that will be sustainable and economical. An experimental study is therefore needed to demonstrate the advantages of this modified concrete. Tailing waste and dolomite waste can be used in concrete to improve its strength and other durability factors.

1.3 OBJECTIVES

A critical analysis of the past studies on the usage of tailing waste as fine aggregate and dolomite waste as cement in concrete justifies its use in concrete. Still, detailed research on tailing waste as a partial substitute of cement and dolomite waste as a substitute of river sand in concrete incorporating different engineering properties essential for the structural requirement is currently required to evaluate its application in this field. The main aim of this research study is to find the use and influence of the tailing waste as a partial substitute of cement and dolomite waste as a substitute of river sand in concrete; as well as to investigate the fresh properties, mechanical-durability properties, ductile behaviour and toughness behaviour of concrete with both types of waste material. Taking into consideration the research need found through the analysis of the available literature studies, the finalized objectives of the present study are as follows:

- To evaluate the feasibility of mine tailing waste as partial replacement of cement in concrete.
- To evaluate the feasibility of dolomite waste as partial replacement of fine aggregate in concrete.
- To determine the fresh and mechanical properties of concrete containing mine tailing waste and dolomite waste.
- To determine the durability properties of sustainable concrete containing mine tailing waste and dolomite waste.
- To determine out the optimum proportion of mine tailing waste as cement replacement and dolomite waste as fine aggregate replacement.

2. LITERATURE REVIEW

GENERAL

Today concrete sustainability is a global concern, and its performance-based requirements such as mechanical-durability properties have achieved similar significance. The following section addresses the literature analysis of both the waste materials (tailing waste and dolomite waste) with an emphasis on the problem's complexities.

Literature Review of Tailing Waste

In this subsection, the number of studies available on the various types of tailing waste as a partial replacement of cement and fine aggregate in the mortar/concrete has been reviewed property wise by emphasizing the scope of the problem.

Workability

Pyo*et al.* (2018) used quartz-based mine tailing in the production of ultra-high- performance concrete. The silica sand and silica powder were replaced with the quartz- based mine tailing at 50% and 100%. They revealed that the workability of the concrete decreased with the substitution of the silica powder and increased with the substitution of the silica sand. They reported that the thin platelet-shaped particles of the quartz-based mine tailing reduced the flow as the particles interlocked combined with each other during the fresh state.

Xu *et al.* (2018) carried out a study on the kaolin tailing sand as a partial substitute of the natural river sand. They evaluated the effect of the kaolin tailing sand on the fresh properties of the concrete. The slump test was conducted by them to evaluate the influence of the kaolin tailing sand on the workability of the concrete. The concrete mixtures were prepared with the fly ash or slag as a mineral admixture with the kaolin tailing sand. The natural river sand was replaced at 0%, 60% and 100% by the kaolin tailing sand. They found that the slump of the concrete decreased with the inclusion of the kaolin tailing sand. They reported the rough and angular texture of the kaolin tailing sand with the high water absorption capacity results in a decrease in the workability of the concrete.

Compressive Strength

undu*et al.* (2016)analyzed the stabilization characteristics of copper tailing in concrete. The copper tailing was used as a partial substitute for cement in the concrete. They designed a M25 grade of concrete with the 0.5 w/c ratio as per Indian standard. The cement was replaced at 0 to 50% with the copper mine tailing. They evaluated the effectiveness of the solidification treatment by calculating unconfined compressive strength. They observed a reduction in the unconfined compressive strength of concrete with the increase in the cement substitution level. The 50% substitution of cement results in a 36% decrease in the compressive strength of concrete. They showed that the 10-15% substitution of cement by copper tailing had exhibited adequate strength. They also suggested developing the concrete with a moderate amount of copper tailing results in economical and sustainable utilization of waste.

Dandautiya and Singh (2019) studied the combined effect of fly ash and copper tailing in concrete. Cement was replaced with fly ash and copper tailing waste in concrete. In their study, they designed M30 grade concrete as per the Indian standard code. The optimum replacement level for cement was found 10% fly ash and 5% copper tailing waste. Compressive strength was improved by 8.27% with the 10% fly ash and 5% copper tailing waste inclusion in the concrete compared to the control mix. They also reported that the pozzolanic compounds in the fly and copper tailing were satisfied the ASTM requirement.

Han *et al.* (2019) prepared the steam-cured concrete with the iron ore tailing waste. The precast concrete was prepared by 50% substitution of cement with the iron ore tailing and 0.4 w/c ratios. The steam curing was carried out with a maximum temperature of 60 degrees and for 24 hours. After the steam curing, the precast concrete was kept in the curing room at 20-degree temperature and 95% relative humidity for the 1, 3, 7, 28 and 90 days. They observed that the 50% replacement of cement by the iron ore tailing reduced the compressive strength of the precast concrete. The chemically bound water did not effectively increase with the utilization of fly ash and iron ore tailing. The pore structure of the precast concrete increased with the substitution of cement. They suggested using of iron-tailing waste as a mineral admixture in the production of precast steam cured concrete.

Peng *et al.* (2021) used graphite tailing to produce the autoclaved aerated concrete. Graphite tailing was used as an alternate silica source. The effect of cement content, Ca/Si ratio, w/s ratio and the foaming agent was examined on the concrete properties. They found that the autoclaved aerated concrete was successfully produced with the strength grade of A5.0 (5 MPa) using graphite tailing waste. They also reported that except for the cement content, the other parameter (Ca/Si ratio, w/s ratio and foaming agent) affect the compressive strength of the autoclaved aerated concrete. They reported with the increase in the cement content up to 15% the compressive strength of the autoclaved aerated concrete increased and after that, with the higher dosages of the cement content it was found reduced. They observed that the decrease in the amount of the calcium silicate hydrate and tobermorite results in the reduction of the compressive strength.

Flexure Strength

Gupta *et al.* (2017) utilized copper tailing in the development of sustainable concrete. The natural river sand was replaced with copper tailing at 0 to 80%. They evaluated the flexure strength of the concrete beam samples at 7 and 28 days. They observed that the flexure strength of the concrete increased up to 50% and after that, it was found reduced with the increasing percentage of the copper tailing as a partial substitute of natural river sand. However, they also observed that the flexure strength of all the copper tailing samples was found greater than the control concrete sample. They reported that the 70% copper tailing could be used in different applications.

Bangalore Chinnappa and Karra (2020) reported the increase in the flexure strength of the concrete containing iron ore tailing as a fine aggregate in the alccofine based concrete. They recorded the highest flexure strength at the 40%, 30% and 20% inclusion of iron ore tailing with the 0.35, 0.40 and 0.45w/c respectively. They reported with the increase in the w/c ratio the flexure strength of the concrete decreased.

Modulus of Elasticity

Gao *et al.* (2020) carried out a study on the molybdenum tailing in concrete. The molybdenum tailing was used as a partial substitute of the sand in the concrete. The natural sand was replaced at 0, 25, 50, and 100% in the different mix proportions. They evaluated the elastic modulus of the concrete after the 3, 7 and 28 days of curing. They observed a reduction in the elastic modulus of the concrete with the substitution of the natural sand. They noticed reduction of 0.5%, 0.5% and 0.8% respectively at the 25%, 50%, and 100% substitution of the natural sand in the C-50 grade concrete. The modulus of elasticity of the concrete decreased slightly due to the small particle size of the molybdenum tailing which acts as a micro aggregate and required more cement. They found that the molybdenum tailing waste was suitable for structural concrete preparation.

Zhang *et al.* (2020) investigated the effect of copper tailing in concrete. They used river sand, copper tailing sand and manufactured sand in the production of the concrete. They observed modulus elasticity of the concrete increased for the copper tailing sand compared to the river sand and manufactured sand concrete. The modulus of elasticity of the concrete containing copper tailing sand was found 7.5% and 4.8% higher than manufactured sand concrete and river sand respectively. This was due to the higher interlocking effect and denser interfacial transition zone of the copper tailing sand concrete.

Abrasion Resistance

Che *et al.* (2019) carried out a study on the iron ore tailing concrete. They developed low-grade cement concrete by using iron ore tailing as a partial substitute of natural sand. They reported that the abrasion resistance of the concrete was found below the 2 kg/m3, which satisfied the requirement of the low-grade concrete. They also stated that the iron ore tailing concrete was suitable for the development of low-grade rural pavements.

Water Absorption

Onuaguluchi and Eren (2012)analyzed the effect of the copper tailing as a partial substitute of cement in concrete. The copper tailing was used to replace cement at 0, 5, 10, and 15% by weight. They observed that the water absorption and voids of the concrete increased with the inclusion of the copper tailing waste. They noted water absorption in the concrete sample at 15.5%, 16.2%, 16.4% and 16.9% respectively for the concrete sample containing 0, 5, 10, and 15% copper tailing. This was attributed to the porous particles of the copper tailing and their low reactivity in the concrete.
Prahallada and Shantappa (2014)analyzed the effect of the copper tailing waste on concrete. The copper tailing was used at 0, 10, 20, 30, 40 and 50% as a partial substitute of the cement. They observed that the water absorption percentage of the concrete decreased with the incorporation of the copper tailing waste. they also reported that the copper tailing waste increased the durability properties of the concrete.
Filho *et al.* (2017) studied the effect of iron ore tailing on interlocking concrete paver blocks development. Natural aggregate was replaced with the iron ore tailing at 10% to 80% in the 10% incremental level. The water absorption and porosity of the paver blocks were evaluated. The water absorption and porosity of the concrete paver blocks decreased with the increase in the natural aggregate substitution level with the iron ore tailing. They reported that the percentage of the voids reduced by about 25% with the use of the iron ore tailing as compared to the natural sand concrete paver blocks. The reported the main reason of the decrease in the water absorption and porosity was that the small particle size of the iron ore tailing act as a filler in the concrete. The iron ore tailings paver blocks showed better durability properties than that the natural sand paver blocks.

Freeze-Thaw Resistance

Wong *et al.* (2004) carried out a comparative analysis on the silica fume, metakaolin and calcined fine tailing as a supplementary cementitious material in concrete. They replaced cement individually with the 7.5% silica fume, 7.5% metakaolin and 7.5% calcined fine tailing. The freeze-thaw resistance of the concrete samples was examined after the 300 cycles. They reported that the small mass loss and expansion occurred after the 300 freeze-thaw cycles in all the samples. The concrete containing 7.5% silica fume showed the highest resistance among all. The metakaolin and calcined fine tailing based concrete also showed better performance. The scaling resistance of the calcined fine tailing concrete samples after the 50 cycles was found lower than the silica fume and greater than the metakaloin. The mass loss was found lowest in the calcined fine tailing concrete samples. This improvement in the freeze-thaw resistance in the calcined fine tailing was due to the pore refinement by the pozzolanic reaction.
Wang *et al.* (2020)analyzed the degradation characteristics of cement mortar containing the graphite tailing subjected to freeze-thaw. The sand was replaced with the graphite tailing waste at 0, 10, 20, 30 and 40% in the predation of cement mortar. The freeze and thaw cycles were varied by 0-100 cycles. They found the relative compressive strength and dynamic elastic modulus. They observed that the graphite tailing incorporation in the cement mortar reduced the degradation of cement mortar subjected to freeze-thaw cycles. The relative compressive strength and dynamic elastic modulus increased at 25 N and 75 N due to the large pore volume, which easily released the ice pressure. They reported that graphite tailing was used in the production of building material in cold zones.
Cheng *et al.* (2020) carried out a study on the concrete containing activated siliceous iron tailing. They replaced cement with the activated siliceous iron tailing at the 10, 20, 30 and 40%. After the 25, 50, 75 and 100 cycles of the freeze-thaw, the mass loss and dynamic elastic modulus were calculated. They observed an increase in the frost resistance of the concrete containing activated siliceous iron tailing. They reported that the frost resistance of the concrete containing 30% activated siliceous iron tailing had a better frost resistance than the control concrete.

Literature Review of Dolomite Waste

In this subsection, the number of studies available on the dolomite waste as partial replacement of cement and fine aggregate in concrete and other application has been reviewed property wise by emphasizing the scope of the problem. However, due to less availability of research studies on the dolomite waste the other research studies on the calcareous material have also been reviewed.

Workability

Korjakins*et al*. (2008) investigated the application of dolomite filler in concrete. For this dolomite and normal quartz, sand concrete developed. Dolomite sand concrete was prepared by replacing the sand with dolomite at various proportions of 0, 25, 50, 75 and 100% by total sand weight. The slump cone values noted were 105 mm, 100 mm, 90 mm, 80 mm and 70 mm at 0%, 25%, 50%, 75% and 100%, respectively. The test results showed that concrete with dolomite sand content has a lower slump and flow value than normal concrete.
Balakrishnan and Paulose (2013) carried out a study on fly ash and dolomite powder in the Self Compacting Concrete (SCC). SCC was produced with fly ash (FA) at 12.5%, 18.75%, 25% and 37.5% and with dolomite powder (DP) at 6.25%, 12.5% and 25% as partial substitute of cement. It was observed with the fly ash increment the slump flow becomes better and the slump decreases with the increase in dolomite powder as cement replacement. This study revealed that both FA and DP blend well in SCC to improve the overall workability.
Cohen *et al.* (2019) studied the effect of waste dolomite-based quarry-dust as a filler material in Portland cement and fly ash based geopolymeric mixtures. The fresh properties of the mixtures were tested with a small flow table test as per ASTM C230 guidelines. The replacement of the Portland cement and fly ash binders by dolomite- based quarry-dust resulted in a reduction of the flow of the fresh mix with the dolomite- based quarry-dust addition.
Al-khafaji (2019) assessed the impact of dolomite stone on concrete pavement. In this study coarse aggregates were replaced with the dolomite stone. The dolomite stone were used at 0%, 10%, 20%, 30% and 40% to replace the coarse aggregate. The test results showed that with the increase of dolomite aggregate percentage in concrete the slump value was found a decrease. The

slump values 70 mm, 50 mm, 45 mm, 35 mm and 20 mm were found respectively for 0%, 10%, 20%, 30% and 40% coarse aggregate replacement with dolomite stone.

Saranya *et al.* (2021) studied the effect of the steel fibre and dolomite powder (DP) on ground granulated blast furnace slag (GGBS) geopolymer concrete. The ground granulated blast furnace slag was replaced with the dolomite powder at 10, 20, 30, 40 and 50%. The steel fibres were included in the 0.25%, 0.50%, 0.75% and 1.00% of concrete volume. The workability of the geopolymer concrete increased with the substitution of the GGBS with the dolomite powder.

Compressive Strength

Budio *et al.* (2004) carried out an experimental study to study the behaviour of dolomite as a sand substitute in concrete. The dolomite was used to replace the sand at 0%, 25%, 75% and 100%. The test results showed that the dolomite as a sand substitute in concrete decreases the compressive strength of concrete at all replacement levels.

Barbhuiya (2011)analyzed the effect of dolomite powder on the performance of self-compacting concrete. They used dolomite powder to replace the fly ash in the self- compacting concrete. The fly ash was replaced at 0, 25, 50, 75, and 100% with the dolomite powder in the self-compacting concrete mixture. They reported the possibility of dolomite powder for manufacturing self-compacting concrete. The compressive strength of the self-compacting concrete was reduced with the inclusion of the dolomite powder, but it satisfies the structural concrete requirement. It was noticed that the 25% dolomite inclusion in the self-compacting concrete meets the guidelines of the EFNARC.

Mikhailova *et al.* (2013) found the effect of dolomite limestone powder on concrete. The study indicated that the use of the dolomite component is a feasible solution for producing Portland dolomite limestone cement instead of limestone. For this purpose, various mixes were prepared with varying percentages of cement from 0 to 30% at the 5% increment. The compressive test results showed that compressive strength at 25% replacement of cement by dolomite had the highest compressive strength. The compressive strength was increased due to the grinding fineness of dolomite. Microstructure analysis was done to investigate the filler influence. The microstructure analysis showed that dolomite limestone had ultrafine particles that act as additional crystallization grains. The test results confirmed that fine dolomite powder would be used as a cementitious material.

Kohila *et al.* (2018) conducted an experimental investigation on concrete made with dolomite as a partial replacement of cement and copper slag as fine aggregate. The cement was partially replaced by dolomite at 10, 20 and 30 percentages and fine aggregate with copper slag at 25 percent in M25 grade concrete. The test results of compressive strength showed that the replacement of cement by dolomite and sand by copper slag in all the mixes increased the strength in concrete.

Nguyen *etal.* (2018) studied the effect of the dolomite powder on the self- compacting concrete. The concrete mixtures were prepared with 50% cement and 50% pozzolanic material (ground granulated blast furnace slag and low calcium fly ash). It was observed that with the adjustment in the dolomite powder content in the three blended binders the self-compacting mortar produced. The compressive strength of self- compacting mortar improved up to 50% addition of dolomite powder. The highest strength of the self-compacting mortar was found at 30% inclusion of dolomite powder. They reported that incorporating the dolomite powder in the self-compacting concrete satisfies the technical requirement of the self-compacting concrete in the structure development.

Cohen *et al.* (2019) carried out a study on the dolomite quarry waste as a filler in the cement paste and fly ash based geopolymer paste. The dolomite quarry waste was used to replace the cement and fly ash at 0, 10, 20, 30, and 40% by weight. They observed significant improvement in the dolomite-based cement paste's engineering properties and fly ash based geopolymer paste. The cement paste's compressive strength was found to increase with the inclusion of the dolomite quarry waste. They reported the main reason for the increase in the properties was the mechanical anchoring of dolomite quarry waste in the fly ash based geopolymer paste and increased hydration reaction in the cement-based paste. They noticed an increase in the percentage mass loss of cement paste and fly ash based geopolymer paste with the increment in the dolomite addition level.

Chen *et al.* (2020) conducted a study on the light-burnt dolomite as an alternative mineral additive in concrete. The calcinations of the dolomite were conducted at 800℃ to get the magnesium oxide and calcite. The blended cement was prepared with the light- burnt dolomite, which had 27.0% magnesium oxide, 67.9% calcite and other content of silica with other impurities. The light-burnt dolomite was used to substitute the Portland cement at 0%, 5%, 10%, 15%, 20% and 30% by weight. The heat release of the cement paste slightly increased with the inclusion of the light-burnt dolomite. They concluded that the compressive strength of the cement paste increased up to 10% substitution of the Portland cement.

Ye *et al.* (2020) assessed the impact of the dolomite and metakaolin in the alkali- activated slag. The 40% slag was substituted with the combination of the dolomite and metakaolin in the alkali-activated slag. The effect of dolomite and metakaolin on alkali-activated slag was studied with the different curing temperatures (20℃ and 50℃). They showed that the 20% dolomite powder in the alkali-activated slag filled the pores. The optimum replacement percentage for the strength and stability was found at 40% inclusion of the dolomite (20%) and metakaolin (20%). They reported the formation of hydrocalcite increased in the alkali-activated slag with the inclusion of dolomite powder due to the filler effect and enhanced slag reaction. The higher curing temperature resulted in the higher zeolitization in alkali-activated slag but no difference in the chemistry of the matrix.

Flexure Strength

Preethi and Prince (2015) carried out a study on concrete properties containing dolomite powder as a substitute of cement in concrete. The foremost replacement level of dolomite powder containing concrete at 5%, 10%, 15% and 20% were found. They found that the substitution of cement with dolomite powder increase the flexure strength at 10% with a 17.78% increment.

Kumar *et al.* (2016) assessed the impact of dolomite fine particles on the flexure strength properties of concrete. The 0, 5, 10, 15, and 20% of binding material cement were replaced with dolomite in the various mixes. They found the maximum flexure strength at the 5% addition of cement by dolomite fine particles waste. The increment of 2.73% was noted in flexure strength with the reference mix.

Benyamina *et al.* (2019) carried out a study on the limestone fines as partial replacement of the manufactured sand in the self-compacting concrete. The manufactured sand was replaced at 0, 5, 10, 15 and 20% with the limestone fines. They observed the reduction in the flexure strength with the inclusion of the limestone fine in the self- compacting concrete.

Admaneet al. (2020) examined the flexure strength performance of concrete specimens containing dolomite as a partial cement replacement at 0%, 5%, 10% and 15%. The test results showed that flexure strength of concrete increases at 5% and 10% of dolomite as cement replacement and after that, at 15% replacement of cement, the decrease in flexure strength was noted. The highest flexure strength (9.45 MPa) of the concrete specimen was achieved at 10% replacement of cement with dolomite as compared to the reference mix flexure strength (8.11 MPa).

Modulus of Elasticity

Jelcic Rukavina *et al.* (2015) investigated the consequence of dolomite filler as a partial replacement of cement in SCC. Seven mixes were cast to found the influence of dolomite on the modulus of elasticity. A reference mix was prepared with dolomite filler without mineral additives, and the other six mixes made with dolomite filler with mineral additives. Out of which three were made with dolomite filler and metakaolin as fractional cement substitution at 5, 10 and 15% and another three with fly ash at 20%, 30% and 40% cement substitute in SCC. The highest compressive strength, 82.3 MPa, was found at 10% of metakaolin as partial cement substitution with dolomite filler in mix 3. They discovered that the modulus of elasticity of concrete increases with the utilization of dolomite as filler with metakaolin in SCC, and with fly ash, it decreases.

El-Hawary and Nouh (2018) carried out a comparative study on concrete containing limestone and dolomite filler. The cement was partially substituted with the limestone and dolomite at 0, 10, 20 and 30% in the concrete. The elastic modulus of concrete decreased with the substitution of the cement by both fillers. The dolomite filler inclusion in the concrete showed slightly better results in terms of mechanical-durability properties than the limestone filler.

Water Absorption

Isa *et al.* (2016) carried out an experimental investigation on brick made with dolomite quarry waste as fine aggregate replacement. Dolomite sand brick was prepared by replacing the sand with dolomite at various proportions of 0, 25, 50, 75 and 100% by total sand weight. The optimum results at 50% in the D50 mix were found on the water absorption of the D- sand brick.

Lin and Zheng (2020) studied the long-term corrosion behaviour of concrete. The silica fume and dolomite powder were used to replace the cement.The combination of 10% silica fume and 20% dolomite powder showed the minimum water absorption in the concrete. They concluded that the inclusion of mineral admixture silica fume and dolomite increased the durability of concrete.

Freeze-Thaw Resistance

Yan *et al.* (2007) investigated the performance of dolomite aggregate in high- strength concrete (HSC). They used four different types of aggregate (dolomite, granite, quartz, and sandstone) during the research. They found that dolomite aggregate had lesser explosive spalling resistance among the granite and sandstone aggregate in HSC.

Grzeszczyk and Podkowa (2009) studied the effect of the limestone filler in the self-compacting concrete. They reported that the freeze-thaw resistance of the concrete decreased with the substitution of the fly ash. This was attributed to the high fineness of limestone filler and lower cement content in the self-compacting concrete.

Drying Shrinkage

Poornima *et al.* (2019) carried out a study to found the suitability of dolomite sand as a substitute for m-sand in mortar. The drying shrinkage in 1:3 and 1:5 mortar mix at 30%, 50%, and 70% replacement of M-sand was found. The drying shrinkage strain values were found less for 3, 7, and 28 days in both mortar mixes than the conventional mixes.

Dhandapani *et al.* (2018) studied the influence of the limestone calcined clay cement on the shrinkage of concrete. They observed increase in the drying shrinkage with the utilization of the limestone calcined clay as a cement in the concrete. This was attributed to the difference in the pore size of concrete, which increased more with the use of the limestone calcined clay.

Marshdi*et al.* (2018)analyzed the effect of the dolomite in the shrinkage compensating self-compacting concrete. They used dolomite as a shrinkage reducing admixture and expansive agent in self-compacting concrete. They reported that dolomite acts as a combined modifier (shrinkage reducing admixture and as an expansive agent) in the production of shrinkage compensating SCC.

Summary of Literature Review

Literature studies based on the various tailing waste showed the dominant potential of tailing waste as a partial substitute of natural river sand and cement in the concrete. The majority of studies on tailing waste revealed that the use of the tailing waste as river sand and cement influences the mechanical-durability properties of the cement mortar and concrete. The workability decreased with the substitution of river sand, cement and as additive filler in the tailing concrete. The substitution of the river sand by the various tailing waste showed better results in terms of the mechanical properties (compressive strength, flexure strength and modulus of elasticity). The durability properties of the mortar and concrete increased with the incorporation of the tailing waste as river sand and additive filler. The water absorption, porosity, freeze-thaw resistance, drying shrinkage of concrete decreased with the inclusion of the tailing waste as partial substitute of the sand up to a certain extent. However, the substitution of the cement by the tailing waste did not show a clear view on the mechanical-durability performance, as a different type of tailing waste showed a different effect on the concrete results. Many researchers suggested using the tailing waste in mortar and concrete production for economic and sustainable utilization of waste to minimize the environmental impact.

Available research studies based on dolomite waste revealed that the dolomite waste had significant potential for cement, fine aggregate, slag, and pozzolanic material replacement. The various literature studies based on dolomite waste showed that the utilization of dolomite as a binder and fine aggregate in cement-concrete and other applications influences their property. In addition, the studies showed that using the dolomite waste as a partial substitute for cement, slag, and pozzolanic material to a certain extent increases the mechanical properties of concrete and influence the durability properties, simultaneously decrease the workability of concrete. The addition of the dolomite waste up to a certain limit as a partial substitute of cement, slag, and pozzolanic material in concrete increased the compressive strength, flexure strength, and modulus of elasticity. The improved microstructure results in an increase in the mechanical properties of concrete. Some studies have shown the increment in the concrete's water absorption containing dolomite waste. The freeze and thaw resistance of dolomite waste concrete improves with the incorporation of dolomite waste as aggregate and fly ash substitution in concrete. The effect of the drying shrinkage was not found clear with the inclusion of the dolomite in some study it was found increase and in some, it was found decrease. The carbonation of the concrete increased with the inclusion of the dolomite. The literature studies based on the acid attack showed better resistance against the sulfate attack of concrete containing dolomite waste. In the various studies, the fire resistance of the concrete was found improved with the inclusion of the dolomite aggregate. The utilization of dolomite by-products waste as a filler and substitute of cement, slag, and pozzolanic material in concrete decreased the environmental impact and made highly durable eco-friendly mortar and concrete.

Identification of Research Gap

The gap area of this research study was discovered by the review of literature studies focused on the tailing waste and dolomite waste, as described below-

- It is evident from the work reported in the past that though several studies are available on the utilization of various tailing waste and dolomite waste in concrete as partial/full replacement of fine aggregate/cement. The majority of the research on this subject was conducted with different nature and sources of tailing and dolomite waste, which cannot thoroughly validate the results, so a comprehensive study with a specific source is needed to be carried out on the different properties.
- Literature studies focused on the mine tailing waste as a substitute for cement are less available. The researchers mainly focused on the mechanical properties of the concrete containing different mine tailing waste as a filler material and naturalrive sand, while the durability properties were not significantly investigated. There is a lack of fundamental studies based on zinc tailing waste to understand the connection between its characteristics and cementitious property in concrete production.
- Studies available on dolomite waste in the literature had confirmed the utilization of dolomite powder as cement replacement in the production of concrete, but very few of the research studies are available on concrete utilizing dolomite waste as fine aggregate replacement.
- The limited studies are available in the literature showing the combined influence of tailing waste as partial replacement of cement and dolomite waste as partial/full replacement of fine aggregate
- Researchers have reported that the marginal quantity of different types of tailing waste as partial replacement of fine aggregate and dolomite waste as partial replacement of cement had a beneficial effect on the mechanical and durability properties. Whereas, the utilization of tailing waste as partial cement replacement and dolomite waste as partial/full replacement of fine aggregate and combined influence of both the waste in concrete yet to be evaluated.
- The effect of tailing waste as a partial substitute of cement and dolomite waste as a substitute of fine aggregate on the mechanical-durability performance, ductility properties, toughness properties, and abrasion resistance have not been investigated, so there is a need to investigate the influence of these waste on different properties.

• To understand the mechanism of internal concrete structure with tailing waste as a partial substitute of cement and dolomite waste as a substitute of fine aggregate, the microstructure analysis needs to be carried out on the concrete.

• Hence systematic study is therefore needed for the evaluation of different mechanical and durability properties by utilizing tailing waste as partial replacement of cement and dolomite waste as partial/full replacement of fine aggregate.

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