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# "A Review on : Experimental Investigation of Concrete by Partially Replacing Coarse Aggregate with Steel Slag"

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***Abstract:*** The concrete industry is constantly seeking sustainable solutions to minimize environmental impact and optimize resource utilization. One such solution involves the incorporation of industrial by-products like steel slag as aggregates in concrete production. This paper presents a comprehensive review of the utilization of steel slag as a coarse aggregate in concrete. Steel slag, a by-product of the steel industry, is generated during the steelmaking process. Its properties, including high hardness, angularity, and rough texture, make it a potential candidate for replacing traditional coarse aggregates in concrete. Utilizing steel slag as coarse aggregate not only diverts a significant amount of waste from landfills but also reduces the consumption of natural resources, such as natural aggregates. In conclusion, this paper underscores the importance of further research and development to optimize the use of steel slag in concrete mixtures, addressing technical, economic, and environmental considerations to promote its widespread adoption in construction applications.

***Index Terms -*** Steel slag, Industrial by-product, Coarse aggregate, Fine aggregate, Compressive strength.

## 1. INTRODUCTION

Utilizing steel slag as a replacement for coarse aggregate in concrete presents promising avenue for sustainable construction practices. This introduction explores the potential benefits, challenges, and applications of incorporating steel slag into concrete mixtures. Concrete is one of the most widely used construction materials globally, primarily composed of cement, aggregates, water, and admixtures. Coarse aggregates typically constitute a significant portion of the concrete mixture, providing strength, stability, and durability to the structure. However, the extraction of natural aggregates such as gravel and crushed stone poses environmental concerns and depletes natural resources. Therefore, finding alternative materials to replace or supplement traditional aggregates is imperative for the construction industry's sustainability.

## 2. STEEL SLAG

Steel slag, a byproduct of the steel manufacturing process, is generated during the conversion of iron ore into steel. It consists of various oxides and metallic compounds, making it a potential candidate for reuse in construction applications. Historically, steel slag has been predominantly utilized as a substitute for fine aggregate or cement in concrete production. However, recent research has demonstrated its feasibility as a replacement for coarse aggregate, offering several advantages. One of the primary benefits of using steel slag as coarse aggregate in concrete is its environmental sustainability. By diverting steel slag from landfills and utilizing it in construction, the industry can reduce waste generation and minimize its ecological footprint. Additionally, incorporating steel slag into concrete reduces the demand for natural aggregates, preserving natural resources and mitigating the environmental impact of aggregate extraction. Moreover, steel slag possesses engineering properties that make it suitable for use in concrete mixtures. Its angular and rough surface texture enhances the bond between the slag particles and the cement matrix, resulting in improved mechanical properties of the concrete, such as compressive strength, flexural strength, and abrasion resistance. Furthermore, steel slag's relatively high density and low water absorption rate contribute to the durability and long-term performance of concrete structures. Despite these advantages, the utilization of steel slag in concrete also presents certain challenges and considerations. One such challenge is the variability in chemical composition and physical characteristics of steel slag, depending on factors such as the steelmaking process, source materials, and cooling methods. Therefore, proper characterization and quality control measures are essential to ensure consistent and predictable performance of concrete containing steel slag aggregates. Another consideration is the potential for alkali-silica reaction (ASR) in concrete incorporating steel slag aggregates. ASR occurs when reactive silica in aggregates reacts with alkalis from cement and water, leading to expansion and cracking of concrete over time. While steel slag typically contains less reactive silica compared to some natural aggregates, careful selection and testing of slag sources are necessary to mitigate the risk of ASR. Additionally, it can be used in various applications such as construction aggregate, cementitious material in concrete, road construction, and as a fertilizer in agriculture. As a byproduct of steel manufacturing, steel slag can be a costeffective alternative to traditional construction materials, reducing waste and conserving natural resources. Additionally, steel slag's relatively low absorption rate minimizes the risk of alkali-silica reaction, a common cause of concrete deterioration.

**Fig: 1 Sample of steel slag**

### 2.1 Steel Slag as Coarse Aggregate

Researchers [1] Ravikumar H., et.,al [2] Nandini Suri studied the strength and workability of concrete by replacing coarse aggregate with steel slag in various percentage and the result shows that there is 5 to 10% improvement in compressive strength at all grades. Using Steel slag which is a byproduct of steel manufacturing, can be effectively used as a coarse aggregate in concrete applications as it imparts various beneficial properties to concrete mixes. Firstly, its angular shape and rough texture enhance the bond between the aggregate and the cement paste, improving the overall strength and durability of the concrete. Additionally, steel slag aggregates typically have higher densities compared to natural aggregates, resulting in concrete with higher density and improved resistance to abrasion and wear. Moreover, steel slag is chemically stable and possesses hydraulic properties, which contribute to the long-term strength and durability of concrete structures. It also exhibits pozzolanic properties, meaning it can react with calcium hydroxide in the presence of water and form additional cementitious compounds, further enhancing the strength and durability of the concrete. Furthermore, the use of steel slag as a coarse aggregate helps in reducing the environmental impact associated with its disposal while simultaneously conserving natural resources by reducing the need for virgin aggregates. However, proper quality control measures must be implemented during the production and use of steel slag aggregates to ensure consistent performance and to mitigate any potential negative effects on concrete properties. Overall, utilizing steel slag as a coarse aggregate offers a sustainable and economically viable solution for enhancing the properties of concrete mixes.

### 2.2 Mineralogical Composition

Steel slag typically consists of a complex mineralogical composition primarily comprised of calcium silicates, calcium aluminates, and iron oxides. These minerals include compounds like gehlenite, akermanite, melilite, and dicalcium silicate, among others. Additionally, it may contain magnesium, aluminum, and other trace elements depending on the specific source and production process. The exact mineralogy varies due to factors such as the type of steel being produced, the cooling process, and any subsequent treatment methods. Understanding the mineralogical composition is crucial for determining the potential applications and environmental impacts of steel slag utilization.

### 2.3 Chemical Properties of Steel Slag

Steel slag, a byproduct of steel production, possesses various chemical properties that make it suitable for different applications. Primarily composed of calcium, silicon, iron, and aluminum oxides, steel slag exhibits alkalinity due to its high calcium content. This alkalinity makes it useful in neutralizing acidic soils and wastewater. Additionally, steel slag contains trace elements such as magnesium, manganese, and phosphorus, which can contribute to soil fertility when applied as a fertilizer. Its high reactivity with water, which can lead to the release of calcium hydroxide, contributing to the cementitious properties of the material. This property makes steel slag a valuable additive in concrete production, improving durability and reducing environmental impact compared to traditional Portland cement.

## 3. CONCLUSION

It concluded that utilizing steel slag as a substitute for coarse aggregate in construction projects offers a promising solution to both environmental and economic challenges. Steel slag, a byproduct of steel production, is abundantly available and often ends up in landfills, posing environmental hazards. Incorporating it into concrete not only reduces waste but also conserves natural resources by decreasing the demand for traditional aggregates like gravel and sand. Studies have shown that concrete mixes containing steel slag exhibit comparable or even superior mechanical and durability characteristics compared to conventional concrete. Steel slag aggregates contribute to enhanced compressive strength, flexural strength, and resistance to abrasion and chemical attack. This makes them suitable for various applications, including road construction, structural concrete, and pavement bases. Successfully implementation of steel slag in concrete requires careful consideration of factors such as quality control, mix design optimization, and regulatory standards. Proper testing and quality assurance protocols are essential to ensure the desired performance and durability of the concrete mix.

In conclusion, integrating steel slag as a substitute for coarse aggregate in concrete presents a viable solution to mitigate environmental impact, enhance engineering properties, and promote economic sustainability in construction. By harnessing this abundant industrial byproduct, the construction industry can move towards a more circular and resource-efficient model, contributing to the advancement of sustainable development goals.

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