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A Review on Utilization of recycled Aggregate in concrete: Examining the effects of incorporating recycled concrete aggregate or other recycled materials as substitute for natural aggregate in concrete mixtures

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Abstract:

In developed countries, concrete is mostly observed as a valuable resource. Recycling efforts have highlighted the importance of maintaining the required compressive strength when using old concrete in new construction. Research shows that compressive strength depends on factors like adhered mortar, water absorption, abrasion resistance, aggregate size, original concrete strength, curing time, replacement ratio, transition zone between old and new concrete, moisture level, impurities, and environmental conditions. While some studies have suggested methods for adopting recycled aggregates into concrete mixes, there's a need for a simple and environmentally friendly approach that considers the percentage of adhered mortar. This project aims to review existing literature on using recycled concrete as aggregates, focusing on compressive strength, and propose a method for incorporating recycled concrete aggregate while maintaining strength.

Keywords: Construction and demolished concrete, second generation concrete, Adhere, recycling, workability, recycle aggregate, compressive strength

Introduction:

The concrete industry is a significant consumer of energy and raw materials. Consequently, utilizing industrial waste as admixtures in construction offers substantial environmental and economic advantages.

In rapidly developing nations like India, the effective management of hazardous waste materials causes one of the most pressing environmental challenges. There is a significant focus on researching eco-friendly materials to avoid or nullify the environmental footprint of the construction industry and conserve natural resources. Additionally, the practice of dumping demolition concrete waste in landfills accelerates problems and environmental degradation.

Concrete is the premier construction material across the world and the most widely used in all types of civil engineering works, including infrastructure, low and high-rise buildings, defence installations, environment protection and local/domestic developments. Concrete is a manufactured product, essentially consisting of cement, aggregates, water and admixture. Among these, aggregates.

Until quite recently, and despite years of experience in the field, the construction industry has seemed quite oblivious to worries about managing the waste produced. Construction is not only one of greatest generators of waste; it also consumes around 40% of all extracted natural resources. It is thus essential to intervene to encourage more sustainable construction practices. Studies on the use of recycled aggregates have mostly focused on their coarse fraction and ignored the fine fraction. This is basically because the extreme porosity of fine recycled materials leads to reductions in the performance of any composites containing them. The most important characteristics of hardened mortar for wall covering are: mechanical strength, water permeability, adhesive strength and resistance to weathering, and those of fresh mortar are workability, and water retentively. Several

mortars with recycled aggregates are assessed based on these characteristics and by comparison with a reference conventional mortar, in order to verify their performance as renderings.In fact many governments throughout the world have now introduced various measures aimed at reducing the use of primary aggregates and increasing reuse and recycling, where it is technically, economically, or environmentally acceptable

Objective:

As we know Concrete is the most widely used construction material in the world, so there is need to diminish the environmental hazards associated with the itand demand being continually driven through the growth of emerging economies. In fact, concrete is so widely used that global cement and aggregates production contributes about 5% to annual greenhouse gas emissions, a level comparable to the aviation sector. Greenhouse gases released into the atmosphere, such as carbon dioxide, significantly affect the Earth's temperature. Concrete production can also contribute to a progressive depletion of natural resources, resulting in serious environmental damage if left unchecked. Recycling of aggregates was first carried out after II World war in Germany to tackle the problem of disposing large amount of demolition waste caused by the war and simultaneously generate raw material for reconstruction. Recycling of aggregate material from construction and demolition waste may reduce the demand supply gap in this sector. Apart from mounting problems of waste management, other reasons which support adoption of recycling strategy arereduced extraction of raw materials, reduced transportation cost and reduced environmental impact because during their excavation manufacturing, transportation tremendous amount of dust particles are produced.The 2030 Agenda goals of United Nations (UN) aim to achieve reduction of 35% in greenhouse gases (GHGs) emissions, 42% in final energy consumption, and 50% in material extraction.The construction sector exerts a significant influence on addressing key challenges, as it contributes to 40% of worldwide energy consumption, generate over 35% of GHGs , accounts for more than 50% of material extraction, utilizes about 30% of water resources, and it roughly contributes a third of waste production . Within this context, construction and demolition waste (CDW) refers to the debris generated during the phases of constructing, renovating, and dismantling buildings, bridges, and other structures. In developing countries, about 95% of produced CDW is disposed of on landfills or illegal dumping in unoccupied areas, along riverbanks, and onto roadways. Nonetheless, an approximate 90% of CDW holds the capacity for reuse, recycling, or recovery. CDW is a significant environmental challenge due to its considerable contribution to global waste generation.

The objective of this paper is to review and study the effects of incorporating recycled concrete aggregate or other recycled materials as substitute for natural aggregate in concrete mixtures

Literature Review:

1. ***Recycling of Demolished Concrete and Mortar in Manufacturing of Aggregate***

Ramesh Balu Ranpise1 , M. S. Salunkhe

Theycarried out the project is based on the replacement of conventional coarse aggregate (100%) with recycled concrete aggregate. The reason for using only coarse aggregates in recycling is that the fine aggregate replacement in terms of concrete dust increases the water demand of concrete which results in decrease of strength. Due to the presence of cement powder around the recycled aggregates, the water requirement for desired workability increases. Construction materials containing plastic waste exhibited lower unit weight and density as compared to the materials without plastic replacement. This has reported that the lower density of produced composite is ascribed due to the low density of plastic waste and the higher porosity of the materials produced.

Remarks:

From the experimental work carried out on "Recycle of Concrete Aggregates", the following conclusion can be drawn:

a.) The water content used in all mixes is 0.5.
b.) The slump of the normal concrete is observed to be less than the recycled one.
c.) The compressive strength of concrete containing 50% RCA has strength in close proximity to that of normal concrete.
d.) Tensile splitting test shows that concrete has goodtensile strength when replace upto 25-50%.
e.) The strength of concrete is high during initial stages but gradually reduces during later stages.
f.) Water absorption of RCA is higher than natural aggregate.
g.) Due to lack of treatment process for RCA adequate strength is not achieved but by applying more advanced and sophisticated treatment process the strength can be improved.

Thus the usage of RCA in concrete mixture is found to havestrength in close proximity to that of natural aggregate and can be used effectively as a full value component of new concrete.

2. ***Experimental Study of Compressive Strength of Recycled Aggregate Concrete***
Prof. Dharmesh K. Bhagat,Jigar P. Parmar,Yati R. Tank,Darpan H. Gadhiya

Remarks:

a.) Recycling and reuse of building wastes have been found to be an appropriate solution to the problems of dumping hundred of thousands tons of debris accompanied with shortage of natural aggregates. The use of recycled aggregates in concrete prove to be a valuable building materials in technical, environment and economical respect. Use of RCA in concrete save the disposal and land filling cost and produce a sustainable concrete for construction.
b.) From the material testing, it can be concluded that, RCA exhibits comparatively less specific gravity than NA. As the water absorption of RCA was found greater then NA, because of adhering mortar and cement paste. This need to be compensated during mix design. On the other hand, RCA is having comparatively same Bulk Density as NA. But, the impact and crushing value of RCA are comparatively less than NA.
c.) The results of compressive strength shows that, the use of RCA up to 40% affect thefunctional requirements of concrete structure. Also the result of slump test shows there is continuous decrease in workability of concrete mix, as the cement mortar paste is attached to RCA.
d.) The cost analysis indicates that, the cost of construction per m^3 reduces up to certain extents. This research concludes that RCA can be used as constructional material.

3. **Reuse of Solid Waste from Building Demolition for the Replacement of NaturalAggregate**
R. Kamala, Aggregates B. Krishna Rao

Remarks:

Waste tiles are the main problem of tile industries and from demolition buildings. The aim of this investigation was the utilization of tiles collected from demolition buildings in concrete as coarse aggregate. The use of tiles in concrete has positive effects on the environment and obtaining lower costs. Investigations carried out the ceramic scrap from building demolition waste can be used as coarse aggregate. The coarse aggregate can be replaced until 40% of ceramic waste. The following are the observation obtained after studying this experiment

a.) From the above study concluded that increasing the tile percentage from 50 decreases the strength of concrete.

b.) By observing above results we can conclude that by increasing the percentage up to 40 replacement of coarse aggregate the strength increases.

c.) The workability of crushed tile aggregate concrete is equilibrium of fluidity, deformability, filling ability and resistance to segregation. This equilibrium has to be maintained for a sufficient time period to allow for transportation, placing and finishing.

d.) The results obtain shows that there is decrement in the Flexural strength of beams for 56 days. It seems to be economical.

e.) The maximum 28 days split tensile strength was obtained with 40% replacement of crushed tile aggregates and the strength is more at 28 days of curing compared to the NCC mix.

CONCLUSION

The utilization of recycled aggregate in concrete has been extensively studied, with a focus on the effects of incorporating recycled concrete aggregate or other recycled materials as a substitute for natural aggregate in concrete mixtures. The mechanical qualities of concrete, such as its compressive strength, tensile strength, and durability, have been found to improve when recycled aggregate is used. Furthermore, it has been demonstrated that using recycled aggregate lessens the environmental effect of producing concrete by producing less trash.

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