

Alternative Of Natural Sand In Structural Part Manufacturing

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Abstract

There are basically three needs of any construction industry they are Cement, Sand and Aggregates. The prime material is natural sand the is need to prepare the mortar concrete and have an important role in design mixing. In the current time the heavy extraction of river beds is raising the environmental concerns, and also affecting aquatic organism as well. The visually impaired uncovering of stream sand from the waterway beds prompted the shortage of the sand and that influenced the development business so a substitution of normal sand to satisfy the prerequisite of the development business and to forestall the mischief that is causing the streams is required. In this paper, we present a view on different substitution of the regular sand that can utilize an option in solid assembling. This paper also focused on the different chemical and physical properties and strength aspect on concrete and mortar.

Keywords: Copper slag, Alternative Material, Quarry Dust, River sand, Fire Bricks

1. Introduction

At the recent years there is a huge growth in urbanization and industrialization, and this is the main cause behind the depletion of natural resources. Industrial production materials and waste materials need to be dispose and reuse in constructional work that can reduce the constructional cost and mitigate the dependency on the natural resources, like sand that is use in concrete manufacturing [1]. Developing countries like India facing a serious challenge in related to CO₂ emission and environmental imbalance [2]. As concrete the most important material used in construction work its composition is aggregate of cement and sand [3]. The sand is a fine aggregate that is use in making concrete, the problem in producing good quality of natural sand is increasing rapidly and it is expected that there will be a double growth in demand of raw materials for making concrete in upcoming decades [4]. India is a developing country, satisfy its rapid infrastructure growth the demand of natural sand in growing, as it is an important aggregate in making concrete [5]. The natural deposit of sand in India are being used

up causing a serious problem for environment and societies. India is facing serious problem in fulfilling of its demand of natural sand [6]. As the river is main source of getting natural sand, the intensive extraction of sand from river created harmful situations like deepen of river bank sides, lost of vegetation, loss of water retaining soil and many more [7]. These activities disturbed the aquatic live and agricultural activities also, In spite of heavy extraction of sand, India is still facing shortage of natural sand for construction purpose [8]. Now there is a problem for the construction companies in India or other developing countries to find a alternative of natural sand to full the demands of this sector [9]. There is instant need for the construction companies to find a partial or complete alternative of natural sand by other materials that are compatible to it like, crushed rock dust, recycled concrete dust, glass powder, recycled concrete dust, coal ash, copper slag and many other that have researched in last two decades [10]. Reusing the waste materials can help to maintain the ecological balance, save cost of construction and also limit the use of natural resources that will ultimately protect environment [11]. The natural sand is not easily available now a days, it has been transported from long distances, now a days the artificial sand can be a substitute for the natural sand [12]. If look in a global prospects the demand of natural sand in for production of concrete is very high [13]. The grind sand becoming a good alternative for natural sand that is manufactured by crushing large quarry and becoming beneficial and commonly available in the world. If the artificial sand make in proper proportion of fine aggregates then the sand will be lesser voids and will be more economical [14]. We are evidencing the increase of this manufactured fine aggregates in the modern world [15]. Another alternative for the natural sand is copper slag created by assembling copper, paper pulp is an another option that can replace and eradicate the dependency on concrete as it contains low amount of silica, minimum amount of calcium and maximum amount of calcium chloride [16]. Paper pulp act like a cement just due to its silica and magnesium properties, the silica and magnesium are helpful in improvement of setting in concrete and its use can also save the problem of disposal of paper and save cost and produced green concrete for production [17].

2. Methodology

Primarily this study is focused on the properties, tensile strength, compressive strength, and durability strength of material that can be used as a alternative of natural sand in concrete manufacturing e.g. quarry dust, copper slag etc. The deceleration test and compaction factor test measure the practicality of the composite design. After preparing the concrete samples they were cured underwater for a specified period of 7, 14 and 28 days. Compressive and tensile strength tests were carried out to determine the strength of concrete and comparative analysis was carried out with ordinary concrete.

3. Materials and Mix Designs

We can say that Concrete is the most important substance that is use in construction, is a mixture of sand, water and gravel which hardens it into a very strong material [18]. For any construction the concrete is the base, In-fact, after the water concrete is second most consumable material on earth. With nearly 3 tones of use to each person annually,

the India uses 450 million cubic meter of concrete in itself, that is approximately comes one tonne per Indian as a consumption [19]. It is estimated by the researchers that the consumption of concrete will be double in upcoming decades [20]. We have long way to go in infrastructural developments, now the question that rise do we have enough natural sand to make mortar or concrete? [21]. Thus, this is increasingly becoming a discomfoting question for those who talked about greening the industry with no practical answers [22]. To cope with this situation some researchers suggested alternatives for the natural sand, here below we will explain them one by one [23].

Crushed Rock Sand

The crushed rock sand is produced by crushing the new rocks and they have normally more angular and a higher surface texture in comparison of the natural sand particles [24]. The crushed rock sand are generally produced form metamorphic, diorite, granite, limestone some other parent rocks [25]. The crushed Rock Sand properties depend upon its lithological character, composition and production process [26]. Various of equipment use crush the rocks, including the cone crusher, impact crusher, rod crusher and rod mills [27]. Reduction of rock content in the shape of granular particles through various types of crushing is an important process in forming crushed rock aggregates [28]. To achieve the final result, we need to adopt the crushing rock process in actual rock type and to its intended end use is important [29]. That means that the choice of the crusher, their combinations, numbers of crushing stages, feedings, gaps and the operation of individual crusher and maintenance also effect the properties of the crushed rock sand [30]. The crushed rock sand crusher equipment are divided into two parts one is compressed crusher second is impact crusher, the sand can be screened in various process like wet, moist or dry, generally two process are used one is screening and second is hydro-clone process in screening of sand, basically that help to remove the dirt and the high fines of the sand [31]. A typical manufacturing process of crushed rock sand is given figure 1[32].

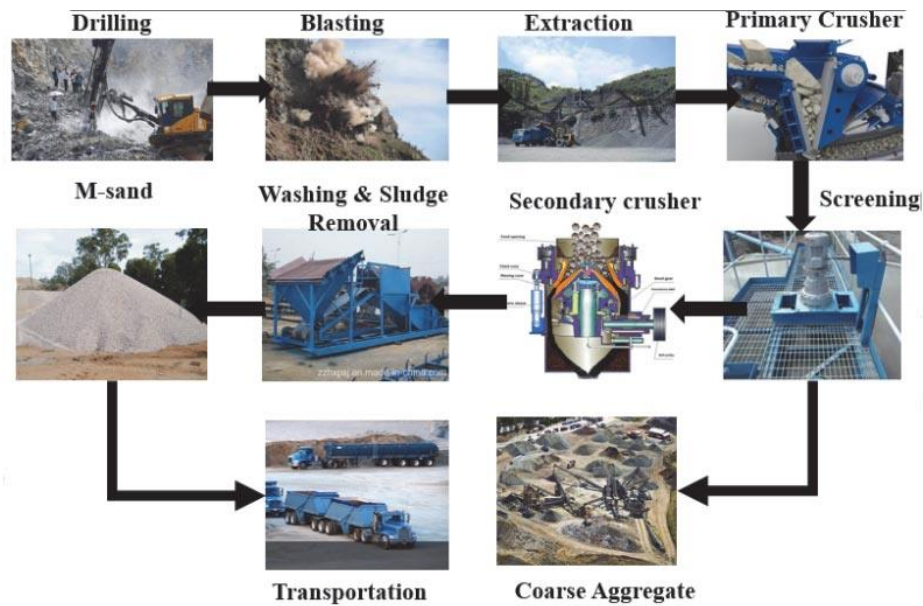


Figure 1. Manufacturing Process of Crushed Rock Sand

Copper Slag

Slag is a sub particle of the copper extract at the time of the formation of copper slag, in the process of smelting the copper get down itself in the smelter because of its higher density thus the impurities remain at the top layer after that transported to a water basin for the solidification, at the end the obtained material is solid and hard material that goes to the crusher for the next process [33]. In the present time the India is producing the 33 million tones copper in a year in whole world prospect, India is contributing to 6 to 6.6 million tonnes In which 50 % of Copper Slag can be used as an alternative of the river sand for the manufacturing of the concrete and mortar [34]. The Central Road Research Institute recommends that Copper Slag could be utilized as a fractional swap for the regular sand as a fine total in concrete and up to half in pavement concrete, with no misfortune in compressive and flexural strength. It is additionally perceptible that such concrete likewise show 20 % higher strength in correlation of customary concrete cement of same evaluations [35].

Quarry Dust

Quarry Dust is a fine rock particle it is formed when the boulders break in small particles [36]. Its color is gray and that is a fine aggregate, it is a good alternative for the natural sand. Instead of that we can utilize the waste of quarry waste that can reduce the production cost of the concrete [37]. The Quarry dust is a sub product of the Granite Stones, formed during the breaking down process of stones into coarse aggregates of different size [38]. We are showing the a picture of Quarry Dust in figure 2 [39].



Figure 2. Quarry Dust

Glass Sheet Powder

Glass is a formless natural substance containing high silica content [40]. It is easily available in country like India, it is very hard material [41]. The glass powder is powdered in desired shape before adding in the concrete, it has been found that if we replace the glass sheet powder in cement with 20 %, 30% and 40% respectively than it increases the concrete strength by 19.6%, 25.3% and 33.7% respectively, many attempts has been done for hours to made glass powder as an aggregate of concrete but always it has been found, concrete made of glass powder always cracks [42].

Foundry Sand

We should not hesitate in saying that the Concrete is most extensively using substance in world right now after water [43]. In the process of urbanization or industrialization has increased the demand of concrete, this lead the heavy exploitation of natural resources, thus become need to search alternative for the natural sand, the researches of last decades several studies conduct on waste foundry paper, it has been found suitable replacement for the foundry sand. The India's ranking is fourth in production of foundry sand that is consist of silica regular excrete by the metal industry [44]. At the present time no mechanism is available for the disposition of the waste of foundry paper but an international studies says that 50% of waste can be utilize in economical and sustainable development in concrete manufacturing [45].

Spent Fire Bricks

The material that is used in manufacturing of fire bricks are high purity clay-s of non plastics and refractory grog [46]. In this process various of raw materials were pressed and homogenized at high capacity in order to get the desired size and shape and then after they were fired in Oil Fire Kl-in at a 1300° temperature. It has been adopted partially by many industries to as fine aggregate of the concrete [47].

Construction and Demolition Waste

The waste generates everywhere, where the construction and demolition activity happen like in building of roads, subway flyovers, reconstructing the buildings etc [48]. Demolition materials generally contains the non- bio-degradable materials and Inert, like Plastic, Metal Woods and Concrete Plasters. These waste is hugely occupied the space that is considerable [49]. A statement by the Municipal Corporation Of Delhi tells that it has collected about four thousand tonnes of waste from the construction and demolition daily from the Delhi city and in a year it is estimated about 1.5 million tonnes of waste, which is illegally dumped. If the waste recycled than it can substitute the demand of natural sand of the city [50]. The research said that, this recycled waste can be 10 to 15 % lesser in strength and normally it can be usable in non constructional activities for example in flooring and filling [51].

Washed Bottom Ash

The Wash Bottom Ash is generally accumulated from the waste of Electrical Plants, mainly from the bottom of the combustion chambers that filled in a Hopper [52], furnace type decides the type of bottom ash, 80% of the Coal becomes fly ash during the burning process of the coal and remaining becomes the bottom ash, the figure 3 is illustrating the combustion process of coal [53].

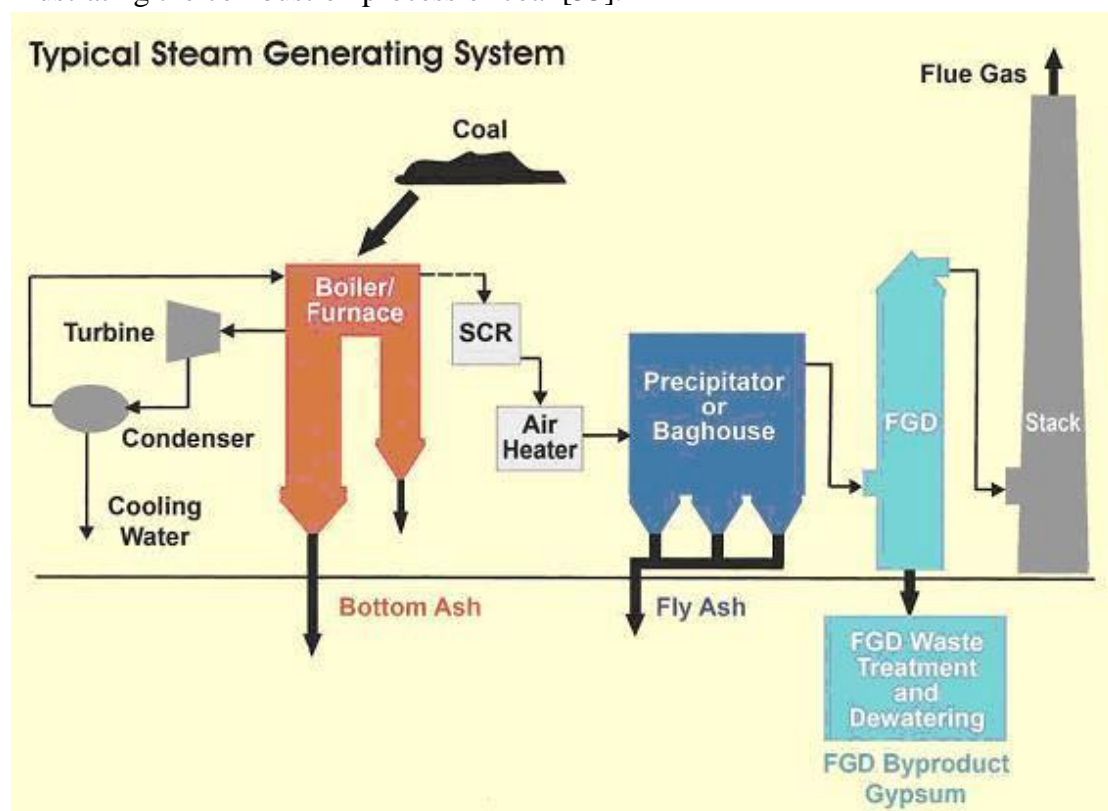


Figure 3. Coal combustion process

4. Different Alternatives Physical and Chemical Properties

Copper Slag

The visually impaired uncovering of copper slag from the waterway beds prompted the shortage of the sand and that influenced the development business so a substitution of normal sand to satisfy the prerequisite of the development business and to forestall the mischief that is causing the streams is required [54]. We present a view on different substitution of the regular sand that can utilize an option in solid assembling. The table 1 is presenting the fitness test data of the Copper slag [55].

Table 1. Fitness test of Copper Slag

Sieve Size in (mm)	Weight retained(b)g	Cumulative Weight retained(g)	Slag retained (n)g	Slag passing % of Soil
4.75mm	4	0.4	0.4	99.6
2.36mm	17	1.7	2.1	97.9
1.18mm	225	22.5	24.6	75.4
600 micron	433	43.3	67.9	32.1
300 micron	281	28.1	96	4
150 micron	37	3.7	99.7	0.3
75 micron	3	0.3	100	0
Pan	0	0	100	0

Wash Bottom Ash

The sum of cumulative percentage that remains in the sieve on the standard of series 150, 300 and 600 um 1-8,2-36 and up to 5 mm is the actually result as the fineness modulus if the larger sieve has been used [56]. The bottom ash fineness modulus is calculated 3.65 which is more than 3.5 that is considered as very coarse. The concrete is mix of the different concrete mixes on a fix amount of the water the constant ration of cement that is 0.55, and made with the various proportions and one control mix proportion [57].

Sheet Glass Powder

Glass Sheet Powder is advantageous for utilizing as a total in Concrete, the compressive strength is test for the consequence of the solid that were containing sheet glass powder is as a fine totals of block as per their age is very much like one another [58]. We found the that the work-ability of concrete is increased as the percentage of sheet glass powder increase in the concrete but it decreases when the curing days increase because of alkali silica reaction [59].

Quarry Dust

When we used the quarry dust as an aggregate in concrete then it increased the compressive strength of the concrete but this increment is depend on the percentage of the sand that is replaced with it the concrete also depend on the place from where the dust has been taken thus the work-ability of the concrete is decreases when there was increase in the percentage of quarry dust at the place of sand [60].

5. Benefits of Alternative Sand in construction

The artificial sand will be widely available and easy to get near the construction sites therefore the transportation cost will be reduced and it will assure the availability of material on time [61].

The particles size will be controlled in CRS and RFA. These alternative sand are Eco-friendly in nature and economical they and their carbon emission is also low, they help in the dumping of the waste materials [62].

The alternative sand improves the mechanical property and durability of the concrete in comparison of the concrete made of natural sand [63].

Using the alternative sand will be protective in exploitation of river beds this can be preventive in environmental catastrophe like water scarcity on ground and etc [64].

6. Demerits of Alternative Sand

Artificial sand can be thicker and angular shaped in comparison of the river sand that is naturally smooth and round due to the gradation work-ability that could increase its cost [65].

Second is it contains larger amount of the micro fine particles in comparison of the river sand due to its manufacturing process as a result it affects the strength and the work-ability of the concrete [66].

Artificial sand contains low moisture in comparison of the natural sand, the natural sand trapped moisture in that is required for the good concentrating [67].

The Artificial sand demand is high so there is possibility of adulteration of extraneous materials in it [68].

7. Recommendation

The environmental problems are creating a need for their solutions, if these problems are not solved then we can see an extensive environmental degradation in near future, the dumping of the waste material is a major problem for the environment, related to our study the heavy extraction of river bed is causing problems for the aquatic organisms. We can see a loss of ground water level by this process, the extraction of river beds for fulfilling the requirement of the natural sand for infrastructure is creating a serious threat for our environment, the researchers have found an alternative for the natural sand requirement, the artificial sand can be used as a substitute of the natural sand, that is lesser in cost and easily available. The government of India should set an example by constructing the bridges and buildings by artificial sand and should promote it. Research and development institutes can play an important role in promoting the artificial sand by enhancing its quality and work-ability [69].

8. Conclusion

In this study we have gone through the various alternatives that could be used in place of the river sand in concrete manufacturing. Through our study we find that we are getting more dependent on the river sand for the concrete aggregate this led to environmental imbalance, this situation gives a room to find an alternative for the natural sand as soon as possible. Many developed countries identified this problem, they are making global

position in production of manufacturing artificial sand for construction work, during our study we observed that various alternatives are available for replacing the natural sand, we mentioned them in our study, after that we studies about the physical and chemical properties and observed, copper slags can improve flexural, compressive and split tensile strength with addition of it. The solid thickness expanded by the copper and furthermore the supplanting of sand with copper builds the strength of up to 40 % . . It was also observed that to get favorable strength the natural sand can be replace with the Washed Bottom Ash, which beneficial in saving environment and cost also the halfway supplanting of quarry dust with regular sand can likewise expand the compressive strength of the solid yet it is additionally seen that the water ingestion diminishes the usefulness of the concrete. Replacement foundry sand to natural sand can also improve the compressive strength and flexural strength of the concrete. Another point saw that supplanting of normal sand with Spent Fire Brick the compressive and flexural strength can be improved up to 30%. In this paper we present a view on the alternatives that can be use to at the place of natural sand in concrete manufacturing, by this study we can say that no material is a waste, anything can be utilized and reuse, whether the product is domestic or industrial. The researchers identified this and focus to utilize these waste material they invested their time and spread awareness that these material can fulfill the demand of construction sector of natural sand , we discussed few alternative material for replacement of natural sand in this paper, these material can be utilized for concrete mix and this information should be spread to the society

Data Availability

The data used to support the findings of this study are included in the article.

Conflicts of Interest

There is no conflict of interest among authors

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