International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 7 ǁ July 2022 ǁ PP. 19-22

Review on Use of Sea Sand and Bamboo As Building Materials

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Abstract
The fine aggregate and steel used as reinforcement are the at most important parts of the concrete structure. There are many essential roles of the fine aggregate during construction. Some of the main roles are – strength, workability, bonding, dimensional stability and prevention of segregation. The fine aggregate plays an important role in reducing crack formation in the concrete by reducing shrinkage. The steel provides that ductile property required by the structure. The effect of seismic loading and other heavy loading are reduced due to the ductile characteristics possessed by the steel. The steel act as an indicator to show the signs of building failure. It provides the occupants sufficient time for retrofitting. The growing demand for both river sand and steel are causing major environmental issues. The continuous extraction of sand from the river leads to flooding in the nearby areas. The continuous extraction and manufacturing process for steel leads to increased amount of release of carbon dioxide to the atmosphere which causes global warming. Global warming is an serious matter affecting the entire planet. The need for an alternative for both river sand and steel is essential. Sea sand and bamboo are the best-known alternative for both. The characteristics and the properties of bamboo and sea sand are discussed in this paper.

Keywords: Sea sand, Bamboo, Global warming.

Date of Submission: 18-06-2022 Date of acceptance: 02-07-2022

I. INTRODUCTION

The fine aggregate provide proper workability required in the mix and also provide proper uniformity to the mix. There are other important roles of the fine aggregate also these include providing strength, elastic and thermal properties. It also provide sufficient dimensional and volume stability. The proper filling of gapes between the mix. The segregation of the cement paste coarse aggregate is prevented by the fine aggregate. The continuous use of river sand for construction has lead to many harmful effect to both aquatic ecosystem and our environment as well. The mating pattern, migration and eating habits of many aquatic species are disturbed due to the extraction of sand from the river bed. The continuous extraction has also lead to flooding of the nearby areas during winter season. An alternative to the river sand is required to overcome the issue of the caused by using it. The sea sand is an economical and effective option available for use as fine aggregate in construction. Sea sand is abundantly available in the nature and with simple treatment can be used as fine aggregate in concrete mix.

Steel is the main reinforcement provided to the concrete structure. It can take tensile loading without failure. The steel can be used as warning indicator in the concrete structures. The steel shows signs of failure before the structure collapse or completely fails. The ductile characteristics of steel makes it better building material in construction. Steel has capacity to regain its original shape without deformation. This allows steel to carry heavy loads without failure of structure. The modulus of elasticity or young's modulus of steel is 200GPa. Due to the continuous use of steel in the construction, there is a huge demand for steel. The manufacture of steel is process which is causing harmful effect to the environment. Huge amount of carbon dioxide is released to the atmosphere during the manufacturing process of steel. The manufacturing process of 1 kg of steel produces 1.85 tons of carbon dioxide that accounts for almost 8 percent of global carbon dioxide emissions, on considering bamboo emits just 80 times less carbon dioxide. Alternative to steel found in nature is bamboo. The bamboo has sufficient flexural strength, an average of 20 GPa. The bamboo has lower specific weight compared to steel. The modular ratio of bamboo is 6 times greater than steel.

BAMBOO

TYPES OF BAMBOO

The species which has characteristics required for application in construction are-

- *Bambusa Lako* – grows up to 50 ft and 4 inch diameter. It has good black colour.

- *Bambusaoldhamii*– tallest bamboo species which can grow up to 65 ft and 4 inch diameter. Also known as Giant Timber Bamboo.
- *Dendrocalamus Asper* – found in south east asia and grows 65-100ft and 3-8 inch diameter.
- *DendrocalamusBrandisii*- This type of bamboo grows to height 60ft and 6-8 inch diameter.
- *DendrocalamusYunnanicus*– This species grows to 70ft tall.
- *Gigantochloa Apus* – It is a traditionally used building material in Asia. This type of bamboo grows 60 ft height and 4 inch diameter.
- *Gigantochloaatroviolacea*– Best for making furniture. It grows 60 ft and 4 inch diameter.
- *Gigantochloa Atter* – This type of bamboo are straight. It can grow 60 ft height and 4 inch diameter.
- *GigantochloaPseudoarundinacea*– It is grown in Indonesia and grows 40 ft height &4 inch diameter.

BOND STRENGTH

The bamboo has been tested and known to have bond strength similar to that of steel. The bamboo culms are used as reinforcement in concrete and have sufficient bond strength. The bamboo is treated boric acid for 72 hours to prevent insect and pest attacks. The treated bamboo found to have 6-16 times more bond strength than untreated one.

SHEAR STRENGTH

The adhesives used for finding shear strength are - emulsion polymer iso-cyanate (EPI), hybrid polymer adhesive(HPA), melamine- urea formaldehyde (MUF), polyurethane (PUR), and polyvinyl acetate (PVA). The shear strength of glue laminated bamboo is 1.0 MPa and clamping pressure of found as 0.6 MPa.

WATER ABSORPTION CAPACITY OF BAMBOO

Bamboo has high water absorption capacity. The bamboo absorbs water during curing and expands causing radial cracks in concrete. Once curing is completed, bamboo starts shrinking and looses contact with the concrete. This problem can be solved using bitumen kerosene mixture paints, oil paints, readymade bituminous paints etc.

STRENGTH

Under reinforced condition is preferred while using steel as it indicates the signs of failure on the concrete informing the occupants regarding damage. The bamboo is brittle material and over reinforced condition is preferred in which limited ductility is achieved by concrete crushing or working stress is kept lower than that of ultimate strength for reinforced section to provide clear information before failure.

REINFORCEMENT REQUIRED

For bamboo to achieve the strength like the steel, the area of reinforcement materials that is bamboo is increased so that the modular ratio is also increased. To control cracks minimum 3.5% of bamboo reinforcement is required. The steel and bamboo have similar bond strength.

DURABILITY

Durability is major part when dealing with bamboo. The bamboo durability can be improved by eliminating sugar and carbohydrate content that attract insects and other fungi. For smaller constructions the bamboo is plastered , white washed , smoked and soaked in water.

SEA SAND

COMPOSITION

The various chemicals on the sea sand has both favorable and unfavorable effect on the concrete. The main ions in sea water consist of chloride ions, sulphate ions and magnesium ions. The sea water consist of average salt content of 35g/l.

EFFECT OF CHLORIDE SALT ON CONCRETE

Chloride ions enters the concrete structure exposed to chloride salt through diffusion, absorption and wicking. In this process, some chloride ions are present in cement matrix and some in pore solution and the ions are also found trapped in CSH.

The chloride ions present in sodium chloride, magnesium chloride, calcium chloride and potassium chloride reacts with calcium aluminate (C3A) and mono-sulfoaluminate (AFm) to form Friedel's salt ($Ca_4Al_2(OH)_{12}Cl_2{\cdot}4H_2O$) and Kuzel's salt ($Ca_4Al_2(OH)_{12}Cl(SO_4)_{0.5}{\cdot}5H_2O$) . When concrete is exposed to NaCl or KCl solution, microstructure changes and forms friedels salt. Friedels salt formation includes two process – adsorption and anion exchange. In some cases calcium ions are substituted by magnesium ions which leads to transformation of CSH to MSH , where MSH can only be stabilized at low pH. Concrete exposed to calcium chloride solution showed damage due to formation of calcium oxychloride.

EFFECT OF SULPHATE SALTS ON CONCRETE

The main effect of sulphate attack on concrete is due to the presence of Portlandite (Ca(OH2) which is a hydration product. Sulphate content present in sea water as Na2SO4 solution. The sulphate ions enters the concrete and interact with hydration products. Portlandite (Ca(OH2)) can absorb sulphate ion and forms gypsum (CaSO4·2H2O) . Formation of gypsum leads to expansion and cracking. Due to these reasons the use of sea water in construction is mostly avoided. The sea sand can be used for construction after washing with fresh water for 4-5 times.

EFFECT OF SEA WATER

The first stage of corrosion is the attack of preventive layer of steel. When the preventive layer of steel is damaged, concrete becomes highly reactive for the electro chemical corrosion process. The corrosion does not occur evenly on the reinforcement as the ion concentrations are different due to environmental conditions and due to difference in cross section. Due to the corrosion process, the cations and anions are formed at different parts of the reinforcement, this provides full circuit for current supply between cathode end and anode end. Due to the presence of ions, salts reacts with oxygen to produce a heterogenous environment and water solution. These acts as electrolyte and starts electrochemical reaction.

USING SEA SAND AS FINE AGGREGATE

The sea sand can be used for replacement of fine aggregate in construction. With proper washing the salt content of the sea sand can be reduced to .015%. after washing as the level of salt content are reduced it does not pose a potential threat to the concrete structure. The washing with fresh water or river water and proper sieving of the sea sand to remove the corals fragments should be done before preparing the mix.

STRENGTH OF SEA SAND AS FINE AGGREGATE

In strength of the sea sand replacement is a section yet to be explored. The optimum rate for the sea sand with other building materials improve the overall strength of the concrete structure.

A test was done in order to find the optimum replacement of M sand with sea sand. In this test, there were 5 specimens of different replacement value. The standard specimen of size 150X150X150 is used for the compression test. The first cube made completely with M sand, second cube made with 30% replacement of M sand with sea sand, third cube of 50% replacement, fourth cube of 70% replacement value and finally last cube specimen of 100% or complete replacement of M sand with sea sand. The compression test is performed in each case as per IS code specifications. The cubes were casted in M25 grade and tested for compression strength value.

Fig1. Cube samples for 30% and 70% replacement

II. RESULT

The result of the test showed some different results. It was found that the 30% replacement of the M sand with sea sand showed the greatest compression value among other specimens. The 30% replacement is the optimum value for the increased value of compression strength. In this 30% replacement, the sea sand and M sand blends with less pores or gaps inside the structure. The overall density of the specimen is increased in this value. The 70% replacement showed the lowest value and other specimens showed appreciable results in the test.

Fig2. Cube strength for 30% replacement with sea sand

COMBINING SEA SAND AND BAMBOO

The sea sand and bamboo are both unexplored building materials which has great potential. With proper treatment the combination of the both materials are possible. The bamboo treated before using because the bamboo is made up of fibers and the fibers have tendency to absorb water. The treating of bamboo prevents the absorption of water by the fiber. In some studies, it was found that the sea water has seasoning effect on the bamboo. The salts left overs even after washing with fresh water does not have any negative effects on bamboo. The combination of sea sand and bamboo is a better option for low weight structures. The bamboo is known for its ability to withstand during earthquake since ancient times. The structures with bamboo reinforcement has good performance against the actions of ground motion. The sea sand at optimum replacement also shown greater value of 42 MPa at M25 grading. The result shows the potential of using bamboo and sea sand as building materials.

III. Conclusion

The sea sand and bamboo is better option as building material. It has greater potential and unexplored application in the construction sector. The properties of the bamboo and sea sand are suitable when combined and does not have any negative affect on the structure. The bamboo and sea sand has huge potential in the tourist sector. The sea shore resorts made of bamboo is of great demand. The store houses for industries, shipyards, auditoriums, gymnasiums and other facilities can also be made using bamboo and sea sand building materials. The application can be unlimited with proper study of the material and providing proper treatment before application. The review can be concluded as the bamboo and sea sand has suitable properties to be used as building material.

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