BEHAVIOUR OF FIBER REINFORCED CEMENT CONCRETE USING DEMOLITION WASTE .

ABSTRACT

The use of conventional cement concrete as been rapidly increased in past decades. This contributes to the carbon footprint affecting environment during production, construction and service of structures. Large amount of construction demolition waste is been produced world wide. Recycling and using Demolition waste Will reduce carbon footprint thus helps in preservation of environment and leads to sustainable development. This paper presents a discussion on Behavior of fiber reinforced cement concrete using demolition waste.

The combination of Demolition Waste and Steel Fibers Creates a composite material which can be used widely in construction Field. This literature shows results on fiber reinforced cement concrete using demolition waste by analysing Compressive Strength and Tensile strength. Based on result obtained, the use of above composite material in structures can be determined.

KEY WORDS: FRC, Steel Fibers, Demolition waste.

CHAPTER -1

INTRODUCTON

SCOPE : To recycle demolition waste and to use as construction material.

OBJECTIVES

- Collection and segregation of demolition wastes.
- Characterisation of demolition waste.
- Proportioning of M25 concrete with demolition waste by trial.
- Selection of M25 concrete using demolition waste and fiber.
- Addition of different percentage of fiber.
- Workability – Slump test on M25 concrete with and without fiber.
- Compressive strength test and Flexural strength test on M25 concrete with and without fiber.
- Cost analysis and conclusion.

CONSTRUCTION AND DEMOLITION WASTES

Construction and demolition waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, fly over, subway, remodeling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. A part of this waste comes to the municipal stream.

These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or communal waste bin/container. It is not uncommon to see huge piles of such waste, which is heavy as well, stacked on roads especially in large projects, resulting in traffic congestion and disruption. Waste from small generators like individual house construction or demolition, find its way into the nearby municipal bin/vat/waste storage depots, making the municipal waste heavy and degrading its quality for further treatment like composting or energy recovery. Often it finds its way into surface drains, choking them. It constitutes about 10-20 % of the municipal solid waste (excluding large construction projects).

It is estimated that the construction industry in India generates about 10-12 million tons of waste annually. Projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about 55,000 million cu.m. An additional 750 million cu.m. aggregates would be required for achieving the targets of the road sector. Recycling of aggregate material from construction and demolition waste may reduce the demand-supply gap in both these sectors.

While retrievable items such as bricks, wood, metal, titles are recycled, the concrete and masonry waste, accounting for more than 50% of the waste from construction and demolition activities, are not being currently recycled in India. Recycling of concrete and masonry waste is, however, being done abroad in countries like U.K., USA, France, Denmark, Germany and Japan.

Concrete and masonry waste can be recycled by sorting, crushing and sieving into recycled aggregate. This recycled aggregate can be used to make concrete for road construction and building material. Work on recycling of aggregates has been done at Central Building Research Institute (CBRI), Roorkee and Central Road Research Institute (CRRI). New Delhi.The study report stresses the importance of recycling construction waste, creating awareness about the problem of waste management and the availability of technologies for recycling. According to a study commissioned by Technology Information, Forecasting and Assessment Council(TIFAC), 70% of the construction industry is not aware of recycling techniques. The study recommends establishment of quality standards for recycled aggregate materials and recycled aggregate concrete. This would help in setting up a target product quality for producers and assure the user of a minimum quality requirement, thus encouraging him to use it.

FIBRE REINFORCED CONCRETE

Fibre reinforced concrete is a concrete mix that contains short discrete fibres that are uniformly distributed and randomly oriented. As a result of these different formulations, four categories of fibre reinforcing have been created. These include steel fibres, glass fibres, synthetic fibres and

natural fibres. Within these different fibres that character of Fibre Reinforced Concrete changes with varying concrete's, fibre materials, geometries, distribution, orientation and densities.

The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed Volume Fraction (V). V, typically ranges from 0.1 to 3%. Aspect ratio (1/d) is calculated by dividing fibre length (1) by its diameter (d). Fibres with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the modulus of elasticity of the fibre is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increase in the aspect ratio of the fibre usually segments the flexural strength and toughness of the matrix. However, fibres which are too long tend to "ball" in the mix and create workability problems.

The post-cracking response of the concrete, i.e., to improve its energy absorption capacity and apparent ductility, and to provide crack resistance and crack control. Also, it helps to maintain structural integrity and cohesiveness in the material. The initial researches combined with the large volume of follow up research have led to the development of a wide variety of material formulations that fit the definition of Fibre Reinforced Concrete. Steel fibre's tensile strength, modulus of elasticity. stiffness modulus and mechanical deformations provide an excellent means of internal mechanical interlock. This provides a user friendly product with increased ductility that can be used in applications of high impact and fatigue loading without the fear of brittle concrete failure.

Thus, SFRC exhibits better performance not only under static and quasi statically applied loads but also under fatigue, impact, and impulsive loading.

CHAPTER - 2

LITERATURE

Sri Rajesh (2019),in Construction and demolition waste **,**it is estimated that the total solid waste generated in India is about 960 million tones of which the construction waste alone is 14.5 million tones. The disposal of C&D wastes is becoming a major concern in the recent years. The wastes are being disposed off improperly and illegally in order to avoid transportation and tipping costs. Farm land, prime residential areas, pits and low lying areas have become disposal sites. These landfills have also become threats to ground water contamination. Benefits of C&D waste recycling : It eases the production and emission of greenhouse gas and other pollutants by reducing the need to extract raw materials and transporting the materials long distances. It reduces the need for new landfills and the costs involved in it. Recycling saves energy and also reduces the environmental impact. It creates employment opportunities in recycling industries. A lot of money can be saved by reducing the project disposal costs, transportation costs and the cost of new construction materials by recycling old materials onsite. Environmental benefits of recycling construction and demolition waste. The environmental benefits of recycling construction and demolition waste are considerable. By assessing carbon dioxide and energy use at a large scale recycling plant, researchers have shown that, over its 60 year life span, the carbon dioxide emissions prevented will be ten times as much as those produced, and eight times as much energy will be saved, than is used.

MEENU LATHA GOYAL et al **[2019],** in their paper entitled **'Deconstruction and material reuse",** Deconstruction, the sustainable way of decommissioning, is a growing trend in the construction industry. It is a process of carefully dis-assembling a structure so that the material used during the initial construction can be given a second life. In spite of higher cost and time involved with deconstruction, the value of the long term benefits takes a better place and

hence justifies adopting deconstruction over demolition. The effort by AEC (Architecture, Engineering, and Construction) practitioners to adapt to the sustainable methods to reduce the impact on environment due to construction activities is slowly shifting the focus from demolition to deconstruction.

X.L .SUPRIYA et al **[2019]**, in their paper '**Use of aggregates from recycled C&D waste in concrete**", The huge quantity of construction & demolition(C&D) waste is being deposited as a landfill even though it is having potential to reuse. In this work an attempt has made to utilize the C & D waste to form a useful product, i.e. Concrete block at commercial standards. Thus main intention of the work establishment of zero waste concepts in the construction industry was satisfied. The Concrete blocks were tested for its physio-mechanical properties and are successfully satisfy the Indian standard recommendations. The compressive strength is 11.12 MPa, water absorption 9.3%, block density 1846 kg/m' and satisfy durability tents, at 100% replacement. So it is suggested to use C&D waste as replacement of natural aggregates in the concrete blocks.

KRUTIKA .T.P et al **[2019]**,in their paper "**Emodied energy of recycled aggregates** ", Construction and Demolition waste (C&D) waste recycling industry is in a very nascent stage in India. Steady increase in overexploitation of stone quarries, generation of construction and demolition waste, the cost of transportation for disposal and costs of preparing extra landfill space have become environmental and waste management challenges in metropolises C&D waste generated in India is poorly managed by dumping illegally in open space, road sides and water bodies due to inadequate no. of recycling plants for processing. The substantial use of recycled aggregates (RA) reduces the need and demand for natural aggregates and reduces the need of landfill sites and saves huge amount of natural resources. Many research studies and standard codes in India report that recycled aggregates can be potentially used in concrete production. In India very few have attempted to assess the sustainability by computing the embodied energy as a tool to address the environmental performance of recycled aggregates. Hence the present study is to assess and compare the embodied energy of natural aggregates with the recycled aggregates obtained from the case studies carried by Rakesh S and Mangala Keshava (BMS college of Engineering Affiliated to VTU, Bengaluru, India). The case study site selected is in Bengaluru city and the embodied energy of recycled aggregates is computed considering the demolition energy, transportation energy and process energy.

SANJAY. S.N et al **[2019]**,in their paper, "**Sustainable construction and demolition waste management**", The construction sector's rapid growth has been due to increase in the living standards, higher demands for infrastructure, changes in consumption preference, and the increase in general population. The government initiatives like "Housing for All" and "Smart Cities" project in developing new cities and towns have increased the rate of infrastructure development the in country. More than 50% of the population in India is going to live in cities by 2050, This increase in construction activities also increases the rate of Construction &

Demolition (C&D) waste generated. This waste generated should be handled in an effective way if tot it endangers the environment. Due to its composition C&D waste has great potenetial for reuse and recycle which contributes to sustainable construction. However, the processing and utilization of this C&D waste in India is still not widely developed. This paper attempts to study the present state of C&D waste, practices being followed and possible initiatives to be taken to make the process sustainable. The data collection approach includes review of academic papers, official reports and government legislation. This study also discusses about the C&D waste management through which environmental benefits can be achieved through application of new techniques and initiatives that can contribute to sustainable growth.

AMTH KUMAR PAWAR. L.V et al **[2019]**, in their paper "**Replacement of aggregates by C&D waste in pavement quality concrete**", Reusing of Construction and Demolition (C and D) waste is one among the numerous pathways that provide a wide convenience to avert waste materials from infiltrating the landfills and reduces the construction industry reliability on depleting natural resource supplies. Reinstating of fine aggregates in a concrete is studied with five incremental ratios such as 20, 40, 60, 80, and 100%. Since debris are coated with fine cementitious particles, the water absorption potential will be high. Hence, the beneficiation process is carried out by acid treatment process. After beneficiation, the water absorption capacity got reduced by 634. soundness value improved by 29% and specific gravity increased by 13% The aided aggregates were replaced for fine aggregates in M30 and M40 grade concrete. Results show construction and demolition waste as a possible natural aggregate replacement material with nominal changes in their physical characteristics. The changes in the strength properties were compared to control mix. From the study, it is found that an effective replacement of 31.97 and 20.05% of Recycled Fine Aggregate for M30 and M40 grade, respectively. The compressive strength is found to be for M30-37.29 and M40-48:06 Nimm, the flexural strength is found to be for M3010.22 and M40-13,36 N/mm and the fatigue strength for M30 372.356, 89, 562, 48, 249, 23. 732 and 4955 No, of cycles and M40 873.925, 128, 890, 73,664,32, 976 and 7112 No. of cycles for stress ratio 0.55, 0.60, 0.65, 0.70 and 0.75 respectively.

SRIDEVI .N et al **[2019]**, reported in , "**Construction demolition waste**", The huge quantity of construction & demolition(C&D) waste is being deposited as a landfill even though it is having potential to reuse. In this work an attempt has made to utilize the C&D waste to form a useful product, i.e. Concrete block at commercial standards. Thus main intention of the work establishment of zero waste concepts in the construction industry was satisfied. The Concrete blocks were tested for its physio-mechanical properties and are successfully satisfy the Indian standard recommendations. The compressive strength is 11.12MPa, water absorption 9.3%, block density 1846Kg/m3 and satisfy durability tests, at 100% replacement. So it is suggested to use C & D waste as replacement of natural aggregates in the concrete blocks.

Amit Rai and Dr. R.P Joshi et al **[2014]** , reported that FRC is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. These fibers have many benefits. Steel fibers can improve the structural strength to reduce the heavy steel reinforcement requirement. Freeze thaw resistance of the concrete is improved. Durability of the concrete is improved to reduce in the crack widths. Polypropylene and Nylon fibers are used to improve the impact resistance. Many developments have been made in the fiber reinforced concrete and Fiber addition improves ductility of concrete and its post-cracking load-carrying capacity.

A.M. Shende et. al[2014], introduced Steel fibres of 50, 60 and 67 aspect ratio. Result data obtained has been analyzed and compared with a control specimen (0% fibre). A relationship between aspect ratio vs. Compressive strength, aspect ratio vs. flexural strength, aspect ratio vs. Split tensile strength represented graphically. It is observed that compressive strength, split tensile strength and flexural strength are on higher side for 3% fibres as compared to that produced from 0%, 1% and 2% fibres. All the strength properties are observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67. It is observed that compressive strength increases from 11 to 24% with addition of steel fibres.

G. Murali et al. [3] studied the influence of addition of waste materials like lathe waste, soft drink bottle caps, empty waste tins, waste steel powder from workshop at a dosage of 1% of total weight of concrete as fibres. The lathe waste, empty tins, soft drink bottle caps were deformed into the rectangular strips of 3mm width and 10mm length. Experimental investigation was done using M25 mix and tests were carried out as per recommended procedures by relevant codes. The results were compared with conventional concrete and it was observed that concrete.

Abdul Ghaffar, Amit S. Chavhan, Dr.R.S.Tatwawadi [2014], The purpose of this research is based on the investigation of the use of steel fibres in structural concrete to enhance the mechanical properties of concrete. The objective of the study was to determine and compare the differences in properties of concrete containing without fibres and concrete with fibres. This investigation was carried out using several tests, compressive test and flexural test. A total of eleven mix batches of concrete containing 0% to 5% with an interval of 0.5% by wt. of cement. "Hooked' steel fibres were tested to determine the enhancement of mechanical properties of concrete. The workability of concrete significantly reduced as the fibre dosage rate increases.

Rubén Serrano et al; [2016], The decrease in concrete resistance and the expansion generated in reinforced concrete structures by direct exposure to fire at 400 C maximum temperatures serves as the basis for the present research. The aim is to improve these problems by the addition of steel fibers or of polypropylene fibers in concrete. From the results analysis of compression fracture tests on cylindrical concrete specimens, it can be concluded that concrete with addition of polypropylene fibers or steel fibers are a good alternative to traditional concrete,

because both its strength, and its behavior in case of fire are improved, delaying the appearance of fissures and explosive concrete spalling.

Ali Amin and Stephen J. Foster et al **(2016).** Despite the increased awareness of Steel Fibre Reinforced Concrete (SFRC) in practice and research. SFRC is yet to find common application in load bearing or shear critical building structural elements. Although the far majority of studies on SFRC have focused on members containing fibres only, in most practical applications of SFRC construction, structural members made of SFRC are also reinforced with conventional reinforcing steel for shear ligatures. In this paper, results are presented on shear tests which have been conducted on ten 5 m long by 0.3 m wide by 0.7 m high rectangular simply supported beams with varying transverse and steel fibre reinforcement ratios. The tests have been analysed along with complete material characterisation which quantify the post-cracking behaviour of the SFRC.

CONCLUSION

A comprehensive review of literature covering papers from Journals and conferences was carried out: papers reviewed were predominantly based on fiber reinforced concrete and demolition wastes. The literature review indicates that very few publications are available on the demolition waste and fiber reinforced concrete with steel fibers, Variables such as aspect ratio, different grades of concretes and different percentages of steel fibers are simultaneously not covered in papers reviewed. No work is reported in the development of mathematical models and their validation using own experimental values and values from other researches.considering parameters like compressive strength and Flexural Strength for Steel fiber reinforced concrete using demolition waste.

CHAPTER – 3

METHODOLOGY

MATERIALS

- CEMENT : Ordinary Portland cement of grade 53 conforming IS code.
- FINE AGGREGATE : Crushed demolition waste passing 4.5mm IS sieve.
- COARSE AGGREGATE : Segregated aggregates retaining 4.5mm IS sieve and passing 20mm IS sieve.
- WATER : Required amount of water as per IS code recommendation.
- SUPERPLSTICIZERS : If required.
- STEEL FIBERS : Stainless steel fibers.

MIX PROPORTON OF CONCRETE.

- The mix proportion is designed for M25 concrete conforming IS codes.

FRESH PROPERTY OF CONCRETE

WORKABILITY

- SLUMP TEST : The slump is carried to know the workability of concrete. The mix design of concrete is done for 25mm to 50mm slump. The test will be carried on cylindrical cone of size 150*300*300mm.The test is carried on concrete with and without steel fibers. Based on the outcome of slump, the results will evaluated.

CASTING AND TESTING.

In the present study, four different M25 concrete mixes were considered of which one mix without fibers and three with steel fibers of percentages 1%, 2% and 4% respectively. After assessing fresh properties, the concrete will be casted in different moulds. The moulds used are either made of caste iron or wood. The cue size is 150mm (compressive strength), cylindrical mould of size 150*300mm (tensile strength).After filling the mould the casting surface will e leveled and finished using trowel. The moulds are kept undisturbed for 24 hours. After 24 hours, the moulds are remolded and the specimens were immersed in water for curing under controlled environment. The specimens are tested at 7 days and 28 days, and the results will be analysed.

HARDENED PROPERTIES OF CONCRETE.

- COMPRESSIVE STRENGTH : Compressive strength can be defined as the maximum stress a material can sustain under crush loading. Compressive strength is calculated by dividing the maximum load by the original cross-sectional area of a specimen. In the present investigation, uniaxial compression test were carried on concrete cubes of size 150mm using a universal testing machine of load 1000kN.The results are noted and evaluated.

- TENSILE STRENGTH : Concrete is inherently weak in resisting the tensile forces. Addition of fibers will enhance the tensile capacity of concrete and the range of enhancement depends on various parameters. To evaluate the tensile capacity, split tensile test was carried out on 150*300mm cylindrical specimens. The test was done by introducing a cylindrical specimen horizontally between the loading surface of the compression testing machine and the load is applied until the failure of the cylinder, along the vertical diameter. When the load is applied, vertical diameter of the cylinder is subjected to a horizontal stress of $2P/\pi ld$. The obtained results are noted and evaluated.

SUMMARY :