FLEXURAL BEHAVIOUR OF BASALT FIBRE REINFORCED CONCRETE FILLED STEEL TUBE BEAMS

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***Abstract*—"Composite members consisting of steel and concrete have the advantages of both materials, steel has high tensile strength and ductility, while concrete has the advantages of high compressive strength and stiffness. The tensile strength of concrete is very low because normally concrete contains numerous micro cracks.This paper introduces an innovative reinforced concrete filled steel tube beams for improved flexural behaviour and reduced deflection of steel and concrete composite structures. The strength and ductility of the core concrete are the important factors that influence the bearing capacity of concrete – filled steel tube structures. Previous studies have demonstrated that the mechanical property of core CFST is the key factor determining the bearing capacity of steel tubes and its other properties. The incorporation of fibre has become the main approach for improving the mechanical properties of concrete. At present, fibres are mainly used in concrete including basalt fibre. The study is aimed at the effect of basalt fibre on the flexural behaviour of Concrete Filled Mild Steel Tube Beams. Basalt fibre of 12mm length and 13µm diameter is used for the study. The fibre is mixed with M30 grade concrete. Conventional concrete is tested for its compressive strength using 9 cubes at the age of 3, 14 and 28 days. Basalt Fibre Reinforced Concrete (0.5% by weight of cement & 0.75% by weight of cement) is also tested for the above properties. Three steel tubes of size 100 x 50 mm and length 900mm with depth to thickness ratio (d/t) of 28.5 are filled with different types of concrete (normal and basalt fibre reinforced concrete).Basalt Fibre Reinforced Concrete in – filled rectangular mild steel tube beams with and without fibre reinforced are tested for the flexural behaviour under four – point load test and the comparative values are recorded and analysed.**

Keywords —CFST;BCF(Basalt Continuous Fibre);

I. INTRODUCTION

Concrete-Filled Steel Tubes (CFTs) are compositemembers consisting of a steel tube in filled with concrete. In current

international practice, CFT columns are used in the primary lateral resistance systems of both braced and unbraced building structures. The CFT structural member has a number of distinct advantages over an equivalent steel, reinforced concrete, or steel-reinforced concrete member. Characterized by advantages such as excellent bearing capacity, rapid construction, and good anti-seismic performance, these structures have been extensively used in bridge and

architectural engineering. Steel tubes filled with concrete increases the steel buckling resistance and heavy stiffeners are not required, which makes composite beams economical and alternative for concrete bridges applications. Concrete materials added many advantages to steel tubes such as increasing the flexural ultimate strength, stiffness, and rigidity of steel tube, significant reducing or eliminating the local buckling of steel tube, and increasing the area under the load-deflection curve (energy absorption) and the overall ductility of the section. The orientation of the steel and concrete in the cross section optimizes the strength and stiffness of the section. The load-bearing capability of CFST structures greatly depends on the performance of core concrete greatly influence on, and previous studies have demonstrated that the mechanical property of core CFST is the key factor determining the bearing capacity of steel tubes and its other properties. The incorporation of fibre has become the main approach for improving the mechanical properties of concrete. At present, fibres used in concrete mainly including basalt fibre.

II. CONCRETE FILLED STEEL TUBES

The concrete-filled steel tubes are composite sections which are used in different areas of construction and becoming an attractive solution. CFST structures are becoming more popular in recent years. Concrete filled steel tubular(CFST) members utilize the advantages of both steel and concrete. Theycomprise of a steel hollow section of circular or rectangular shape filled with plain or reinforced concrete. They are widely used in high-rise and multi storey buildings as columns and beam-columns, and as beams in lowrise industrial buildings where a robust and efficient structural system is required. Concrete-filled steel tubular columns have been used for earthquake-resistant structures, bridge piers subject to impact from traffic, columns to support storage tanks, decks of railways, columns in high-rise buildings and as piles. It offers resistance to applied load through the composite action of steel and concrete and shows good bond strength under fire exposure. In CFST section the steel tube act as longitudinal as well as transverse reinforcement.There are a number of different advantages related to such structural systems in both terms of structural performance and construction sequence.

Fig.1 Rectangular Concrete Filled Steel tube beams

III. BASALT FIBRE

Basalt fibre is a material made from extremely fine fibres of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. It is similar to fiberglass, having better physicomechanical properties than fiberglass, but being significantly cheaper than carbon fibre. It is used as a fireproof textile in the aerospace and automotive industries and can also be used as a composite to produce products such as camera tripods. Basalt fibre possesses advantageous characteristics such as high tensile strength, high elasticity modulus, corrosion resistance, good chemical stability, and no discharge or pollution during production and use. As such, this material has gained increasing attention in engineering application.

Existing studies have focused mainly on the basic mechanical properties of basalt fibre reinforced concrete; however, basalt fibre is rarely used in concrete structure engineering, let alone CFST structures. Therefore, the present study investigates the reinforcing effect of basalt fibre on the bearing capacity of long CFST beams and promotes the application of basalt fibre in CFST structures to elucidate the
extent of the influence of basalt fiber on the flexural behaviour of the concrete filled steel tube beams.

Fig.2 Basalt fibre

IV. PROCEDURE

Hand Mixing:

The cement and fine aggregate was mixed on a water tight non -absorbent platform until the mixture is thoroughly blended and is of uniform colour.The coarse aggregate is added to the mix with the cement and fine aggregate is uniformly distributed throughout the batch. The water is added to the mix it until the concrete appears to be homogenous and of the desired consistency.Basalt fibre is added according to the desired quantity.

Casting:

The mould is cleaned and the oil is applied to the inside of the mould.The mould is filled with concrete in 3 layers of 5cm thickness.Each layer is tamped 25 times using a tamping rod.The top surface of the concrete is levelled and smoothed by trowel.

Curing:

After 24 hours remove the specimen from the mould. Keep the specimen submerged under fresh water.The test specimens without self-curing additives are allowed to cure
water for the given curing periods of 3, 14 and 28 days.The specimen should be removed from the water 30 minutes prior to the testing.The specimen should be in dry condition before conducting the testing.

Testing:

Now place the concrete cubes into the testing machine. (centrally).The cubes should be placed correctly to the machine plate (check the circle marks on the machine). Carefully align the specimen to the spherically seated plate.
The load will be applied to the specimen axially.Now slowly apply the load at the rate of 140kg/cm 2 per minute till the cube collapse.The maximum load at which the specimen breaks is taken as a compressive load.

V. TEST SET UP AND PROCEDURE

The beam is placed on Universal Testing Machine (1000 KN) to find out the Flexural Strength for various proportions. The conventional concrete filled steel tubular beam and other reinforced CFST beam specimens were tested in Electronic Universal Testing Machine (1000 KN) using hydraulic loading with horizontal position to determine the central deflection of the concrete filled steel tubular beam and other beams with cyclic loading. An initial load of 2 KN is given to the specimen to hold it in correct position. At every 2 KN is observed.

VI. FLEXURAL STRENGTH TEST RESULT

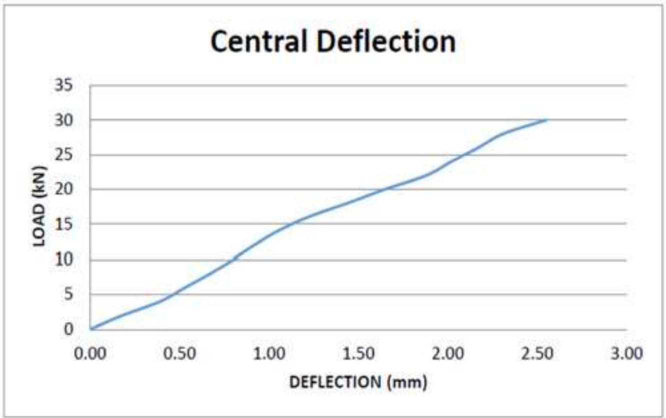

Fig.3 Deflection of conventional CFST beams

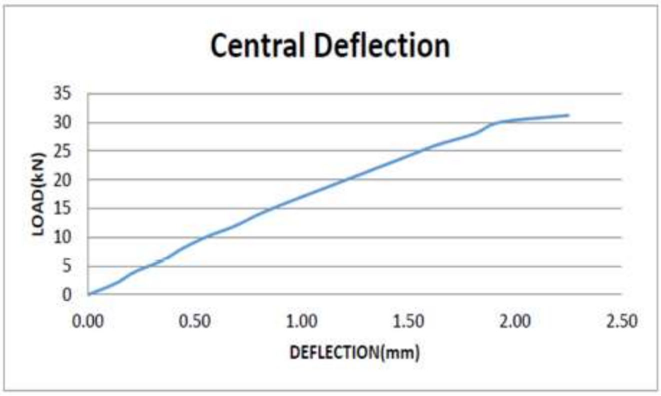

Fig.4 Deflection of 0.5% basalt fibre reinforced CFST beams

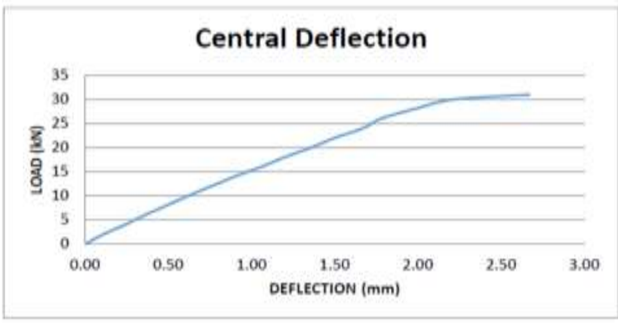

Fig.5 Deflection of 0.75% basalt fibre reinforced CFST beam

TABLE.A
Consolidated results

VII. CONCLUSION

Basalt fibre is found to be an alternative material for fibre forming due to its homogeneous chemical structure. It has been observed that with increase in the percentage of basalt fibre the workability of concrete decreases and there are many solutions to overcome the workability problem. Due the basalt fibre reinforcing, formation of cracks in the BFRC specimens are less than conventional concrete specimens.This proves that fibres reinforced in the concrete act as crack arrestors. In addition to this Basalt fibre improves the ductility characteristics of concrete. 0.5% of volume of basalt fibre increases the flexural strength of CFST 4.3% for 50x100 mm size beams and any furthermore addition of basalt fibre leads to decrease in the flexural strength of the specimen.

The average compressive strength of conventional concrete cube after 28 days of curing is 30.13 N/mm^2.The average compressive strength of 0.5% basalt fibre reinforced concrete cube after 28 days of curing is 44.57 N/mm^2.The average compressive strength of 0.75% basalt fibre reinforced concrete cube after 28 days of curing is 33.65 N/mm^2. The compressive strength of 0.5% basalt fibre by weight of cement reinforced concrete cubes are found to increase by 47.93% than conventional concrete cubes. But the compressive strength of 0.75% basalt fibre by weight of cement reinforced concrete cubes are found to increase only by 11.68% than conventional concrete cubes, which is less than 0.5 % basalt fibre reinforced concrete cubes.Hence 0.5% basalt fibre is optimum.

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SPECIMEN SIZE: 50mmx100mm		
Percentage of fibre	Strength	Deflection (mm)
0%	30KN	2.52
0.5%	31.3KN	2.23
0.75%	30.93KN	2.68