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REVIEW ON BASALT FIBER REINFORCED CONCRETE

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Abstract: ***The plane concrete is strong in compression and it has less strength capacity in tension. In order to overcome the defect of tensile strength capacity, fibre technology was used along with conventional reinforcement. Many fibres are available in the society as natural and synthetic fibres. The synthetic fibres plays major role for construction industry and those are steel, glass, carbon, polypropylene, nylon etc. In recent past the basalt fibres came into the industry as strength enhances material for concrete works. In this view, the present article was focused to know the state of art in this area and same was presented in detail. This article may useful to extend the research work in this arena, who is interested in this area.***

Key Words: Fibre reinforced concrete, Basalt fibres, Strength, Durability, Bond strength, Flexural strength, Temperature.

I.INTRODUCTION

Fiber reinforced concrete (FRC) is a new constructional material established through broad research and progress during the last two decades. In this new constructional material fibers are incorporated in this matrix as micro reinforcement so as to improve the tensile and other properties of concrete. The knowledge of mingling or additional ingredients to obtain a different compound material is not new to the civil engineer. By using short discontinuous fibers, the fiber matrix becomes irregular and discontinuous. In addition to the aspect ratio and its fiber geometry, other factors such as fiber orientation, fiber volume and fabrication techniques profoundly influenced the properties and mode of failure of the fibrous composite. The main part of fibers is to arrest any crack by applying pinching force at the crack tips, which delays the propagation through the matrix and making the slow crack propagation. Hence the final cracking strain of the composite material is increased. The results of fiber as reinforcement in the matrix as well as the effective transfer of stress between the fiber and matrix depend on many factors. Many factors are interdependent and exercise a profound but complex influence on the properties of the composite; these innumerable factors can effectively be reduced to three they are Spacing of fibers, Aspect ratio and Orientation of fiber. Fiber reinforced concrete has been economical for airport and highway pavements. It is also used for applications such as sewer pipes, bridge overlays and curtain walls. Fiber reinforced concrete has been used as it decrease cavitations or erosion, destruction in structure such as sluice ways, spillways and piers of bridges where high velocity flows are witnessed. It is rapidly gaining acceptance as suitable material for repair, recovery and renovation of concrete constructions. Synthetic fibers are used in concrete elements such as in R.C.C like beams, lintels, columns, flooring and wall plastering; foundations, tanks and manhole cover, plastering and pavements. The main functions of fibers in these elements are:

1. Controls cracking
2. Increase in strength
3. Decreases water permeability
4. Decrease in rebound loss
5. Increases flexibility

There are mainly two types of fibbers which are used in concrete. They are:

1. Low Modulus High Elongation Fibres – These have capacity to absorb large amount of energy but do not improves strength. These convey durability, opposition to impact and explosive loading. Ex: Nylon, Polypropylene.

2. High Modulus High Elongation Fibres – These produces strong composite primarily they impart stiffness and strength and also dynamic properties to varying degrees. Ex: Steel, Asbestos, Carbon, basalt and glass.

Basalt fibre introduction

Industry is always striving to find new and better materials to manufacture new or improved products. With this in mind energy conservation, the environment, corrosion risk and sustainability are important factors when a product is changed or a new product is manufactured. A few examples of problem overviews that relate to some of these important factors are explained below. High voltage towers have, almost from the beginning, been designed as steel truss towers and in the next few years will need to be replaced. Therefore there is now the opportunity design a new type of tower made of a new material that is strong, light and has minimum risk of corrosion. A large part of lampposts and telephone poles have also been designed as steel and wood for years and there is also a need for new materials which are strong, light and with a minimum risk of corrosion. Structural designers, as for buildings, bridges and windmills, are always looking for new solutions for better and/or bigger structures. One of the solutions could be a new material which is also strong, light and with minimum risk of corrosion. Aircraft, ships and the automobile industries are always trying to develop lighter units without losing material strength to make energy conservation. In this sense the energy required for the production of basalt fiber is around 5 KWh/kg while for carbon steel product is about 15 KWh/kg. Basalt rock can be used to make not only basalt bars but also basalt fabrics, chopped basalt fibre strands, continuous basalt filament wires and basalt mesh. Some of the potential applications of these basalt composites are: plastic polymer reinforcement, soil strengthening, bridges and highways, industrial floors, heat and sound insulation for residential and industrial buildings, bullet proof vests and retrofitting and rehabilitation of structures. At Structural and Composite Laboratory at Reykjavik University (www.sel.ru.is) have been ongoing several researches about strengthening concrete beams and columns by basalt FRP materials in past years. These tests have shown improvements in strength and durability compared to un strengthen concrete members. Basalt is fine-grained, extrusive, igneous rock composed of plagioclase, feldspar, pyroxene and magnetite, with or without olivine and containing not more than 53 wt% SiO2 and less than 5 wt% total alkalis. Many types of basalt contain phenocrysts of olivine, clinopyroxene (augite) and plagioclase feldspar. Basalt is divided into two main types, alkali basalt and tholeiites. They have a similar concentration of SiO2, but alkali basalts have higher content of NA2O and K2O than tholeiites. The plutonic equivalent of basalt is gabbros. The production of basalt fibres is similar to the production of glass fibres. Basalt is quarried, crushed and washed and then melted at 1500° C (Ross, A., 2006). The molten rock is then extruded through small nozzles to produce continuous filaments of basalt fibre. The basalt fibres do not contain any other additives in a single producing process, which gives additional advantage in cost. It is known that basalt fibres have better tensile strength than E-glass fibres, greater failure strain than carbon fibres as well as good resistance to chemical attack, impact load and fire with less poisonous fumes. From the above introduction, it is observed that among the fibres the basalt has its own importance for concrete works. So in this view the research works happened from 1996 to 2016 has been furnishing below.

II. STATE OF ART ON BASALT FIBRE

Senol Yilmaz et.al.,(1996) studied the crystallization behaviour of basalt glass at elevated temperatures was studied using glass samples prepared by melting the natural basalt rock from the Thrace region of Turkey. Differential thermal analysis (DTA) and X-ray diffraction (XRD) analysis revealed the crystallization of Augite [(Ca Fe Mg) SiO3 at 800^0 C]. The kinetics of crystallization of augite were studied by applying the DTA measurements carried out at different heating rates and the activation energies of crystallization and viscous flow were measured as 238 kJ mol^{-1} and 413 kJ mol^{-1} respectively The resultant basalt glass-ceramic revealed very fine and homogeneous microstructure.

Joung man park et.al., (1999) investigated the fibre matrix interfacial properties and interfacial shear strengths (IFSS) in epoxy composites reinforced by dual basalt and SiC fibres by the fragmentation method combined with acoustic emission analysis. Statistical analysis of fibre tensile strength was performed in terms of statistical parameters. The tensile strength and elongation of basalt and SiC fibres decreased with increased gauge length because of the size effect. Fibre tensile strength above an optimum concentration decreased because of stress concentration at lumps in coating, when an Amino Silane coupling agent was used the IFSS showed significant of more than three times under dry conditions. The IFSS also considerably improved under wet conditions. The environment effect is probably due to chemical and hydrogen bonds as well as to intri diffusion effect in two different interphases in the fibre saline coupling agent epoxy matrix system. In situ monitoring of Acoustic Emission (AE) during straing of Duel fibre composite (DFC) specimen showed the sequential occurrence of distinct groups of AE data. The first group may have come from fibre breakages and the second mainly from cracking of epoxy matrix. Characteristics frequencies coming from the different failure modes of the fibre and epoxy matrix were investigated by fast Fourier transform analysis by setting an appropriate threshold level. A one-to- one correspondence between the number of AE events and fibre breakages was established. The AE method correlated with fragmentation technique of obtaining the IFSS value.

Jiri Militky et.al, (2002) conducted the work on basalt fibres to evaluate the tensile failure under thermal influence. In this contribution selected ultimate tensile properties of basalt fibres are presented. Properties are investigated after tempering to the 50, 100, 200&300^0C. Scanning electron microscopy identifies structural changes of fibres. The distempering to stress at break is described by the Weibull type model. It was postulated that fracture occurs due to non homogeneities in fibre volume (probably near the small crystallites of minerals). The analysis of fibrous fragment evolved during abrasion of basalt weave is presented. Despite of fact that basalt particle are too thick to be re-spiralble the handing of basalt fibres must be carried out with care.

Jon sung Sim et.al, (2005) investigated the applicability of the basalt fibre as a strengthening material for structural concrete members through various experimental work for durability, mechanical properties and flexural strengthening. The basalt fibre used in this study was manufactured in Russia and exhibited the tensile strength of 1000 MPa, which was about 30% of the carbon and 60% of the high strength glass (S-glass) fibre. When the fibres were immersed into an alkali solution, the basalt and glass fibres lost their volumes and strengths with reaction product on the surface but the carbon fibre did not show significant strength reduction. From the accelerated weathering test, the basalt fibre was found to provide better resistance than the glass fibre. However, the basalt fibre kept about 90% of the normal temperature strength after exposure at 600^0C for 2hrs, whereas the carbon and the glass fibres did not maintain their volumetric integrity. In the tests of flexural, the basalt fibre strengthening improved both the yielding and the ultimate strength of the beam specimen up to 27% depending on the number of layers applied. From the results presented herein, two layers of the basalt fibre sheets were thought to be better strengthening scheme. In addition, the strengthening does not need to extend over the entire length of flexural member. When moderate structural strengthening but high resistance for fire is simultaneously sought such as for building structures, the basalt fibre strengthening will be a good alternative methodology among other fibre reinforced polymer (FRP) strengthening systems. Dylmar Penteado Dias and Clelio Thaumaturgo (2005) investigated the influence of the volumetric fraction of the fibres on the fracture toughness of geo polymeric cement concretes reinforced with basalt fibres. The values of fracture toughness, critical intensity factor and critical crack mouth opening displacement were measured on 18 notched beams tested by three-point bending. The a0/h (notch height /beam height) ratio was equal to 0.2 and the L_0/h (distance between the supports / beam height) ratio was equal to 3.According to the experimental results, geo polymeric concretes have better fracture properties than conventional Portland cement and also less sensitive to the presence of cracks. Tibor czigany et.al.,(2005) studied the applicability of basalt fibres as reinforcing materials in a polypropylene (PP) matrix. The brittle basalt fibres have been mixed with the PP fibres by carding with needle punching and the composite sheets have been produced by pressing. SEN-T fracture mechanical specimens have been cut out of the sheets and the sensitivity to crack propagation has been examined in the composites. It has been proven that fracture toughness increase as result of reinforcing. The toughness of the composite increased compared to matrix due to the gravels appeared at the end of basalt fibres. It has been pointed out that the gravels are results of the Junkers production technology. The observations have also been proven by electron microscopic images. A model has been outlined for investigation of influence of change of technological parameters on basalt fibre production.

T. Czigany (2006) studied the mechanical and acoustic emission properties of basalt and polypropylene composites. Basalt fibre reinforced, polypropylene matrix hybrid composites were manufactured in the process of carding, needle punching and pressing. Hemp, glass and carbon fibres were applied besides basalt fibre in these composites. In order to achieve a sufficient interfacial adhesion, the fibres were treated with the reaction mixture of malefic acid anhydride and sunflower oil. The hybrid effect in these composites was examined as a function of fibre content and fibre combination. The strength properties of hybrid composites improved owing to surface treatment and this was proven by mechanical tests and microscopic analysis as well. Acoustic emission methods revealed that there is a correlation between the physical parameters of sound waves that occurred during failure and the mechanical properties**.**

Bulent Ozturk et.al, (2007) evaluated the friction and weir properties of ceramic and basalt fibre reinforced materials. Ceramic fibre content was kept constant at 10 volume % and basalt fibre content was changed between 0 to 40 Vol%. Mechanical properties and friction and wear characteristics of friction materials were determined using a pin-on-disc type apparatus against a cast iron counter face in the sliding speeds of 3.2-12.8 m/s , disc temperature of 100-350^0C and applied loads of 312.5 – 625 N. The worn surfaces of the specimens were examined by SEM. Experiments show that fibre content has a significant influence on the mechanical and tri biological properties of the composites. The friction coefficient of the hybrid friction materials was increased with increasing additional basalt fibre content. But the specific wear rates of the composites decreased up to 30 volume% fibre content and the increase again above this value. The wear tests showed that the coefficient of friction decreases with increasing load and speed but increases with increasing disc temperature up to 300^0C. The most important factor effecting wear rate was the disc temperature followed by sliding speed. The materials showing higher specific wear rates gave relatively coarser wear particles. XRD studies showed that Fe and Fe_2O_3 were present in wear debris at severe wear conditions which is indicating the disc wear. G.J. Wang et.al, (2007) expressed the surface modification and characterizations of basalt fibres in the non thermal plasma. Atmospheric – pressure non-thermal plasmas have been increasingly promoted for polymer surface modification. In their study, atmospheric- pressure plasmas of oxygen, argon, and hydrogen and mixture gases of nitrogen were used to surface modification of basalt fibres in order to illuminate their chemical durability, surface active groups and roughness etc. The plasma- induced surface changes on morphologies and active groups were characterized by scanning electron microscope (SEM) and X-ray photoelectron spectroscopy (XPS). The results exhibited a remarkable increase in chemical stability and excellent adhesion , accompanied by extensive etching and by the implantation of both oxygen – and nitrogen – containing polar groups such as NH_2, OH and so forth, Etching of oxygen was mainly a consequence of ion bombardment, yielding low molecular weight and roughness, while surface chemical modifications of mixture of hydrogen and nitrogen were mainly due to the action of neutral species on the plasma –activated basalt fibre surface. The possible formation mechanism of functional groups on the basalt fibre surface was shown.

Martin Cerny et.al, (2009) conducted the experimental work to evaluate the mechanical properties of partially paralyzed at 650^{0}C or 750^{0}C unidirectional basalt fibre composites with polysiloxane matrix at laboratory and elevated temperatures. Ten pyrolysis processes differing mutually in heating courses and ultimate temperatures were compared. The material treated at 650^{0}C revealed at laboratory temperature flexural strength around 850 MPa. Fracture toughness of this material exceeded that of the cured only (at 250^{0}C) and treated at 750^{0}C composites. However, the composite pyrolyzed at 750^{0}C is more suitable for application at elevated temperatures because of its slower degradation in hot air**.** C. Sheffler et.al, (2009) studied the alkali resistant of glass and basalt fibre and the failure analysis was determined by using Weibull distribution function. In alkaline solutions, the reaction of hydroxyl ions with Si-O-Si groups of the glass network leads to the formation of hydrated surfaces and dissolved silicate. The rate of this corrosion depends on the chemical constitution of the fibre and the alkaline solution as well as on time and temperature. The investigation of the aging of glass and basalt fibres with different chemical constitutions in NaOH and cement solutions shows that the corrosion mechanism changes due to the inhibiting effect of calcium ions. The strength distributions have been evaluated using a Weibull distribution function. The mechanical behaviour strongly depends on the chemistry of the solution and determines the parameters of the Weibull distribution function in terms of either single or mixed distributions. The corrosion in NaOH solution leads to a strong dissolution of the outer layer of the glass and basalt fibres, whereas during aging in cement solution at the same PH- value a limited, local attack was revealed. Weimin Li and Jinyu Xu (2009) studied the mechanical properties of basalt fibre reinforced geopolymeric concrete (BFRGC) including dynamic compressive strength, deformation and energy absorption capacity, were studied using a 100- diameter spilt Hopkinson pressure bas (SHPB) tests on BFRC specimens, the improved pulse shaping techniques were proposed to obtain dynamic stress equilibrium and nearly constant strain rate loading over most of the test durations. Impact properties of BFRGC exhibit strong strain rate dependency, and increase approximately linearly with the strain rate. The addition of basalt fibre can significance improves deformation and energy absorption capacities of geo polymeric concrete (GC) while there is no notable improvement in dynamic compressive strength. In addition, the optimum volume fraction of basalt fibre was presented for BFRGC.

Salvatore Carmisciano et.al, (2011) presented the comparative study of basalt and E-glass woven fabric reinforced composites. The fabrics were characterized by the same weave pattern and the laminates tested by the same fibre volume fraction. Results of the flexural and inter laminar characterization are reported. Basalt fibre composites showed higher flexural modulus and apparent inter laminar characterization are reported. Basalt fibre composites showed higher flexural modulus and apparent inter laminar shear strength (ILSS) in comparison with E- glass ones but also a lower flexural strength (ILSS) in comparison with E-glass ones but also a lower flexural strength and similar electrical properties. With this fibre volume fraction, scanning electron microscopy (SEM) analysis of the fractured surfaces enabled a better understanding both of the failure modes involved and of points of concern. Nevertheless, the results of this study seem promising in view of a full exploitation of basalt fibres as reinforcement in polymer matrix composites (PMCs). Bin Wei et.al.,(2011) studied the degradation effect of basalt and glass fibre effect in seawater. Epoxy resins reinforced by basalt fibres and glass fibres, were treated with a seawater solution for different periods of time, both the mass gain ratio and the strength maintenance ratio of the composites were examined after the treatment. The facture surfaces were characterized using scanning electron microscopy. The tensile and bending strengths of the seawater treated samples showed a decreasing trend with treating time. In general, the anti- seawater corrosion property of the basalt fibre reinforced composites was almost the same as that of the glass fibre reinforced ones. Based on the experiments-reinforced composites was almost the same as that of the glass fibre reinforced ones. Based on the experimental results, possible corrosion mechanisms were explored. Indicating that an effective lowering of the Fe^{2+} content in the Basalt fibre could lead to a higher stability for the basalt fibre reinforced composites in a sweater environment.

Tumadhir Merawi Borhan (2012) carried out the experimental work to know the properties aggregate concrete reinforced with chopped basalt fibre. Recycled waste mixed colour glass was used as a partial replacement (20%, 40%& 60% by weight) for the natural fine aggregate with different volume fractions of fibre (0%, 0.1%, 0.3% & 0.5% by total mix volume). The combined effect of the glass and the basalt fibre on the mechanical properties of the fresh and hardened concrete was investigated. The heat transfer through the thickness for this type of concrete was also investigated. A statistical analysis was carried out to investigate the variance of the data of each mix. The test results and the statistical analysis indicated that there is slight reduction in the compressive and splitting tensile strength with the increase in the glass content above 20% Using basalt fibre leads to an enhancement in it for all mixes and there this an optimum content of fibre in each percentage of glass sand which gives higher strength A slight decrease in the heat transfer through the concrete specimen was observed. Kunal Singha (2012) presented a short review on basalt fibre. A hard, dense, inert rock found worldwide, basalt is an igneous rock which is solidified volcanic lava. Cast basalt liners for steel tubing shows very high abrasions resistance in various industrial applications. In recent years, continuous basalt fibres extruded formant rally fire- resistant basalt are attracted attention as replacement for asbestos fibres at a price point between S-2 glass E-glass, and my offer manufactures a less expensive alternative to carbon fibre. Basalt fibre (BF)is capable to with stand very high temperature and can acts as fire blocking element. Enrico quagliarini et.al.,(2012) presented the characterization of basalt as an engineering material, whose use is increasing in constructions and civil applications as an alternative to glass, carbon or aramidic fibres. Basalt fibre reinforced polymer (BFRP) rods and basalt fibre (BF) ropes are going to be used as an alternative to glass, carbon or aramidic fibres for strengthening purposes but few information about their mechanical performances is present in literature and standard test protocols are missing. Thus, the work tries to provide a test protocol for tensile characterization of BF ropes and a validation of the test protocol used for tensile characterization of not-basalt-FRP rods applied on BFRP rods. It is a very important issue from an engineering standpoint in order to evaluate their applicability for architectural heritage retrofitting, re-pointing (rods), or in innovative techniques, such as the one actually still being tested in our laboratories, that is aimed to strengthen historic masonry (ropes). Experimental test results obtained are shown in their work and results seem to confirm that BFRP rods and BF ropes could be a good alternative to other similar products.

Nihat Morova (2013) studied the usability of basalt fibres in order to bear the stress occurring at the surface layer of pavement, which are directly subjected to the traffic effects. In the context, specimens are produced and tested under the Marshall stability test, and optimum bitumen content value for the aggregates sample to be used was determined based on the determined value for optimum bitumen content (5%), three specimens for each of series of different fibre ratio were prepared the optimum value for fibre ratio that result in the best stability value was determined. In order to determine whether the test fibre ratio (0.5%) might result in a better stability value for other bitumen contents and with best and five different fibres ratio values close to the optimum value the specimens were tested under Marshall Stability test and obtained results were evaluated. Gore Ketan R et.al, (2013) evaluated the performance of high strength concrete (HSC) containing supplementary cementations materials. Concrete had a good future and is unlikely to get replaced by any other material on account of its ease to produce, infinite variability, uniformity, durability and economy with using of basalt fibre in high strength concrete. The main aim of the investigation program is first to prepare the strength of concrete of grade M40 with locally available ingredient and then to studied the effect of different proportion of basalt fibre in the mix and to find optimum range of basalt fibre content in the mix. The concrete specimens were tested at different age level for mechanical properties of concrete, namely, cube compressive strength, split tensile strength, flexural strength, durability of concrete and other test were conducted for cement, chemical admixtures, coarse aggregate &fine aggregate. Jiawei shi et.al, (2013) carried out the experimental investigation on the bond behaviour between basalt fibre reinforced polymer sheet and concrete substrate under the coupled effects of freeze thaw cycles level of sustained load and adhesive type. Double lap shear specimen were used in the test and specially designed reaction loading system was used to apply the sustained load during freeze thaw cycles specimens with or without sustained load were exposed to up to 300 freeze thaw cycles. A modified epoxy resin made by adding at outgoing agent to the original epoxy resin was used in test to study the effect of adhesive type on the durability of the BFRP concrete interface coupon test were also conducted to determine the freeze thaw resistance of the constituent materials of the BFRP concrete interface after exposure double laps residual shear tests were carried out to investigation the bond capacity of the BFRP concrete interface. Digital image correlation measurement was applied capture the full field deformation of the BFRP sheet and the concrete block during the double lap shear test a nonlinear bond slip relationship BFRP concrete interface decreases with increasing freeze thaw cycles the failure mode changes from de-bonding concrete layer to de-bonding the adhesive layer extra degradation of the bond slip relationship could be caused by the coupled effects and the durability movement of the may result in durability BFRP Concrete bond capacity in freeze thaw environment finally the couple effects and evaluation of freeze thaw procedures on the bond degradation of BFRP concrete interface are discussed. MarekUrbanski et.al., (2013) presented the results of pilot research on the series of simply supported beams under flexure, reinforced with BFRP bars and compared to the reference beams with steel reinforcement. The tested beams were made of C30/37 concrete and reinforced with basalt bars with 8mm diameter having and tensile strength evaluated from the tensile tests. The analysis of deflection and cracking behaviour has been presented. The results show the different character of the load-deflection relationship of basalt reinforced beams compared to traditionally steel reinforced beams, as well as the significant influence of the type and quality of anchoring on the process of basalt bars tensile process. P.Amuthakkannan et.al, (2013) focused on the effect of fibre length and fibre content of basalt fibre on mechanical properties of the fabricated composites. Specimen prepared with short basalt fibre as reinforcing materials and polyester resin as a matrix in polymer composite. Based on the availability, different fibre lengths were taken and fabrication was done with compression moulding machine, with increasing the content of fibre in the composites. Specimens were tested to tensile, flexural and impact strength tests, and the failure of the composite was examined with the help of scanning electron microscopy (SEM).Nihat Morova (2013) studied the usability of basalt fibres for pavement works. The study was observed on the stresses occurring at the surface layer of pavement, which are directly subjected to the traffic effects. In this investigation, specimens were produced and tested under Marshall Stability test, and the optimum bitumen content value for the aggregates sample to be used was determined. Based on the determined value for the optimum bitumen content (5%) three specimens for each of a series of different fibre ratios were prepared. The fibre rate was varied from 0.25 to 2.0% with an increment of 0.25%. The experiments were shown as optimum content fibre for this work as 0.5%.In order to determine whether the best fibre ratio (0.50%) might result in a better stability value for other bitumen contents, extra specimens were prepared with different bitumen amounts and with the best and five different fibre ratio values close to the optimum value. The specimens were tested under Marshall Stability Test and the obtained results were evaluated, these results were shown as the use of basalt fibre for pavement has given positive impact related to stability. R.Singaravadivelan et.al, (2013) studied the behaviour of RC beam structures strengthened by using basalt chopped strands fibres. For this work total 8 Nos., of beams were taken and the fibre is added to the concrete at various proportions of (ie.,0%, 0.5%, 1.0%,1.5%,2.0%& 2.5%) concrete mixes. This concrete beams are casted for a grade M-20 as per according to IS10262-2009. The results showed that use of fibre reinforced concrete improve flexural performance of the beams during loading.

RanjitsinhK.Patiul and D.B.Kulkarni (2014) presented the comparative study of basalt, glass and steel fibre on compressive and flexural strength of M40 grade concrete. For flexural and compressive strength of reinforced concrete, total thirty-nine cubes and thirty-nine beams were cast and beams were tested over an effective span of 900 mm up to failure of the beam under two-point loading. The beams were designed as balance-section. The fibres were placed in concrete randomly by (0.25%, 0.5%, 0.75%, &1%) of its total volume of concrete. For each percentage of fibre total three cubes and three beams were casted to take average results. Finally comparative results are shown for each percentage and for those three fibres. Elba Helen George et.al., (2014) studied the mechanical properties of concrete containing fly ash, meta kaolin and basalt fibre (as reinforcement material). Basalt fibre is a single material fibre manufactured by melting of basalt and extruding the molten basalt through small nozzles to produce continuous filaments of basalt fibre. The basalt fibre used in their study has a diameter of 13 µm and a length of 12mm. As the addition of pozzolanic materials to concrete leads to pozzolanic reaction, 2.5% of fly ash and met kaolin by weight of cement is added to concrete. The reaction involves the consumption of hydration product, a $(OH)_2$ and the production of CSH, which enhance the packing efficiency from micromechanics point of view. The grade of concrete chosen is M20 and the respective cubes, cylinders and beams are casted with and without basalt fibre reinforcement. The amount of basalt fibre added is 1% of the total mass of the concrete. Mechanical characterisation such as compression, split tensile and flexural tests are performed and the results shows that, basalt reinforcement enhanced the split and tensile strength of the concrete. Chaohua Jiang et.al.,(2014) studied the effects of the volume fraction and length of basalt fibre (BF) on the mechanical properties of FRC. Coupling with the scanning electron microscope (SEM) and mercury intrusion porosimeter (MIP), the microstructure of BF concrete was also studied. The results show that adding BF significantly improves the tensile strength, flexural strength and toughness index, whereas the compressive strength shows no obvious increase. Furthermore, the length of BF presents an influence on the mechanical properties. Compared with the plain concrete, the compressive, splitting tensile and flexural strength of concrete reinforced with 12mm BF increase by -0.18-4.68%, 14.08-24.34% and 6.30-9.58% respectively. As the BF length increasing to 22mm, corresponding strengths increase by 0.55-5.72%, 14.96-25.51% and 7.35-10.37% separately. A good bond between the BF and the matrix interface is observed in the early age. However, this bond shows degradation to a certain extent at 28 days. Moreover, the MIP results indicate that the concrete containing BF presents higher porosity. Marijonas Sinica et.al, (2014) investigated the impact of a complex additive (CA), consisting of continuous basalt fibres (CBF) and SiO2 micro dust (SMD), on strength properties in autoclaved aerated concrete (AAC) samples within recurrent heating and cooling cycles. Content of CBF in AAC forming mixture was 0.3% from dry mass of solids. SMD was used as 1.0% replacement of sand. It was established that depending on the number of heating and cooling cycles of AAC samples, compressive strength was from 20% to 52%, and flexural strength from 27% to 62% higher comparing with the AAC samples without CA.During the heating and cooling cycles, decrease in the strength of AAC samples is related to the destruction of their structure due to the ongoing dehydration of calcium hydro silicates (C-S-H). Decrease in the ultrasonic wave velocity (UWV) confirms this fact. Scanning electron microscope (SEM) pictures show occurrence of micro-cracks. Changes in the tobermorite crystal identifying peaks are visible in X-ray patterns. Changes in the structure and strength properties of AAC samples, containing CA, are lower, comparing with the AAC samples without CA, due to the corrosion of CBF surface, which takes place in an alkaline environment during the autoclave treatment. This leads to formation of the tobermorite group's calcium hydro silicates (C-S-H) in the damaged areas of CBF, adhesion of them with AAC pore walls, and effect of supplementary of reinforcement. Consequently, thermal deformations of AAC samples, containing CA, isothermally heated during 12 h at 650^o C, was 28% lower comparing with AAC samples. FathimaIrine l. A (2014) investigated the mechanical properties of Basalt fibre concrete and compare the compressive, flexural and splitting tensile strength of basalt fibre reinforced concrete with plain M30 grade concrete. Fibre reinforced concrete is a most widely used solution for improving tensile and flexural strength of concrete. Various types of fibres such as steel, polypropylene, glass and polyester are generally used in concrete. In this research, the effect of inclusion of basalt fibres on the compressive, flexural land splitting tensile strength of fibre reinforced concrete was studied. Based on the laboratory experiment on basalt fibre reinforced concrete, cube, beam and cylindrical specimens have been cast with basalt fibre reinforced concrete containing 1kg/m^3, 2kg/m^3 & 4 kg/m^3 basalt fibres. The experimental test results demonstrated a considerable increases in compression flexural and splitting of specimen at 3,7 and 28 days with addition of basalt fibres.

NayanRathod et.al, (2015) presented the knowledge of basalt fibre (it is relatively new material) for concrete works. Basalt fibre reinforced concrete offers more characteristics such as light weight, good fire resistance and strength. Many applications of basalt fibre are residential, industrial, highway and bridges etc.In their study trial tests for concrete with basalt fibre and without basalt fibre are conducted to know the performance in compressive and flexural strengths by using cubes and concrete beams. Various application of BFRC shown in the study, the experimental test result, Techno- financial comparison with other type presented and indicated the tremendous potential of BFRC as an alternative construction material. ParvezImraan Ansari and Rajiv Chandak (2015) presented the comparative study of basalt fibre effect on compressive and split tensile strength of M40 grade concrete. The basalt fibre was mixed in concrete by (0.5%, 1% and 1.5%) of its total weight of cement in concrete. Results indicated that the strength increases with increase of basalt fibre content up to 1.0% beyond that there is a reduction in strength on increasing basalt fibre. The results show that the concrete specimen with 1.0% of basalt fibre gives better performance when it compared with 0.5% and 1.5% basalt fibre mix in concrete specimens. Ahmad Altalmas et.al, (2015) studied the bond durability on sand-coated basalt fibre-reinforced polymer (BFRP) bars. Pull-out specimens were tested under direct tensile load after being exposed to accelerated conditioning environments. The test parameters included the bar material (basalt and glass), the conditioning environment (acid, saline, and alkaline), and the duration of exposure (30, 60, and 90 days). The bond behaviour of the tested specimens was reported in terms of stress-slip response, bond strength, bar slip, adhesion, and failure mechanism. The BFRP bars showed higher adhesion and bond strengths to concrete than the ribbed glass fibre-reinforced polymer (GFRP) bars irrespective of the fibre type and the exposure condition. The absorption of the bar material and its quality of manufacturing affected the bond behaviour of the conditioned specimens. All specimens failed in pull out mode by inter-laminar shear between the layers of the bar. Conditioning reduced the bond strength of the BFRP bars by 14-25% of their initial strength, Ribbed GFRP specimens subjected to acid exposure suffered the highest loss in bond strength (25%) compared to 17% for GFRP specimens exposed to alkaline and ocean water. Dimas Alan strauss Rambo et.al., (2015) presented the experimental investigation results on the thermo-mechanical properties of a textile refractory composite reinforced with polymer coated basalt fibres under tensile loading. The composites were produced as a laminate material using basalt bi-directional fabric layers as reinforcement. A high alumina cement matrix was used in the matrix composition which was designed using the compressible packing method. A series of uniaxial tensile tests was performed under temperatures ranging from 25 to 1000^0C. The cracking mechanisms were discussed and compared to that obtained at room temperature. Thermo gravimetry and X-ray diffraction analysis were used to study the deterioration/phase changes as a function of the temperatures. Scanning electron microscopy (SEM) was used to study the damage processes in the fibre-matrix interfaces after exposure to high temperatures. The obtained results indicated that the presence and the type of coating can become a deterministic factor in the tensile response of the composite submitted to elevated temperatures. A sudden drop in the serviceability limit state of the composite was observed above 400^0C, caused by the degradation of the polymer used as a fibre surface coating, the degradation of the basalt fibre and by the dehydration process of the refractory matrix. YaV.Lipatov et.al.,(2015) studied the alkali resistant effect on basalt fibre reinforced concrete. Basalt fibre with zirconium content in the range from 0 to 7 wt% was obtained using ZrSiO4 as a zirconium source. Weight loss and tensile strength loss of fibres after refluxing in alkali solution were determined. Basalt fibre with 5.7 wt% ZrO_2 had the best alkali resistance properties. Alkali treatment results in formation of protective surface layer on fibres. Morphology and chemical composition of surface layer were investigated. It was shown that alkali resistance of zirconium doped basalt fibrosis caused by insoluble compounds of $Zr^{4+,}$ Fe^{3+} and Mg^{2+} in corrosion layer. Mechanical properties of initial and leached fibres were evaluated by a Weibull distribution. The properties of basalt fibres with $ZrSiO_4$ were compared with AR-glass fibres. Zuhtu Onur Pehlivanli et.al.,(2015) studied the effect of fibre type and size in the production of AAC on compressive, flexural strength and thermal conductivity values has been investigated. In the study, G2/04 class having 400 Kg/m^3 density of Autoclaved aerated concrete (AAC) production used for wall element and commercially produced was taken as a reference. Fibre types of carbon, polypropthline, basalt and glass were substituted for an equal amount of aggregate and AAC samples were produced. The mechanical properties and thermal conductivity values as well as micro structural features of the sample produced were examined. The samples produced were waited at the temperature of 60^0C in 4 h-cure then they was subjected to the cure at the temperature of 180^0C, at the pressure of 11 bar and in an autoclave for 6.5 h. As well as the mechanical properties of the samples produced and thermal conductivity values, their micro structural features were also examined. In the study, it was seen that fibre was supplemented instead of quartzite increased flexural and compressive strength of AAC and carbon fibre was reinforced AAC gave the best flexural and compressive strength compared to fibre types. AhmetB.Kizikanat et.al, (2015) studied the comparative analyse on the application of basalt and glass fibres as fibre reinforcement in high strength concrete. It was observed from the test results that there was no significant effect of fibre inclusion on the compressive strength and modulus of elasticity of concrete. The splitting tensile strength of basalt fibre reinforced concrete (BFRC) increased with increasing fibre dosage whereas there was no increase in strength for glass fibre reinforced concrete (GFRC) was observed beyond 0.50% fibre dosage. In a trend similar to splitting tensile strength, the flexural strength of BFRC increased with increasing fibre content in a gradual fashion but no such change was observed for GFRC after 0.50% fibre content. Fracture energy increased significantly after 0.25% dosage for both basalt and glass reinforced concrete. The Fracture toughness ($K_{ic)}$ and Crack mouth opening displacement (CTODC) results of the BFRC showed that BF inclusion improves the performance of concrete more when compared to GF with respect to crack resistance and ductility. Fareed Elgabbas et.al.,(2015) investigated the physical, mechanical, and durability characteristics of basalt fibre-reinforced polymer (BFRP) bars. Durability and long-term performance were assessed by conditioning the BFRP bars in an alkaline solution simulating the concrete environment (up to 300 h at 60^0C) to determine their suitability as internal reinforcement for concrete elements. Thereafter, the properties were assessed and compared with the unconditioned (reference) values. In this study, three types of BFRP bars were investigated. The test results revealed that the BFRP bars had good mechanical behaviour and could be placed in the same category as grade II and grade III GFRP bars (according to tensile modulus of elasticity) Their tensile strength, however, was higher than that provided by CAN/CSA S807-10 for CFRP bars. On the other hand, the BFRP bars showed poor alkali resistance and exhibited a remarkable reduction in mechanical properties due to the resin-fibre interface issues, which needs to be remedied to achieve the desired durability characteristics. Cory High et.al.,(2015) investigated the use of basalt fibre bars as flexural reinforcement for concrete members and the use of chopped basalt fibres as an additive to enhance the mechanical properties of concrete. The material characteristics and development length of two commercially-available basalt fibre bars were evaluated. Test results indicate that flexural design of concrete members reinforced with basalt fibre bars should ensure compression failure and satisfying the serviceability requirement. ACI 440, IR-06 accurately predicts the flexural capacity of members reinforced with basalt bars, but it significantly underestimates the deflection at service load level. Use of chopped basalt fibres had little effect on the concrete compressive strength, however significantly enhanced its flexural modulus.

Zuhtu Onur Pehlivanli et.al., (2016) presented the changes in thermal conductivity value, compression and flexural strength of autoclaved aerated concrete were investigated experimentally by adding polypropylene, carbon, basalt and glass fibres into the G3/05 and G4/06 class autoclaved aerated concrete used as wall elements in buildings and the commercial production of which is made. Fibres were substituted with the aggregate in autoclaved aerated concrete in equal amounts volumetrically. The produced samples were subjected to autoclaved cure as in non-fibrous autoclaved aerated concrete. As a result of the experimental study it has been seen the thermal conductivity of fibre substituted autoclaved aerated concrete changes linearly with thermal conductivity of the substituted fibre sand basalt fibre reinforced autoclaved aerated concrete gives the highest thermal conductivity. K.Sarayu et.al.,(2016) studied the de-gradative properties of basalt fibres with altered chemical and biological conditions. Degradative and degenerative properties of the fibres with various chemical and biological stresses explained the structural instability of the basalt fibres. SEM and optical micrographs has clearly shown the spalling and exfoliation of the basalt fibres by leaching out the magic minerals on biochemical degradation. EDX and FTIR data has also revealed the utilization of magic minerals by the microorganisms as their carbon and nitrogen source explaining the rapid degradation of basalt fibres. B.Soares et.al.,(2016) studied the mechanical properties of a Basalt fibre composite in an Unsaturated Polyester matrix produced by Resin Transfer Moulding (RTM), with the composites subjected to tensile, compression, shear and flexural tests. The results aligned with the predicted values by using the mixing rule, albeit with a high coefficient of variation which microscopic analysis confirmed to arise from production issues with RTM. Nasir Shafiq et.al., (2016) presentenced the flexural test results of 21 fibre reinforced concrete (FRC) beams containing Poly vinyl alchol (PVA) and basalt fibres (1-3% by volume) Fibre reinforced concrete was made of three different binders. The first binder type was 100% cement; the other two types were blended cement system containing a part of 10% silica fume or metakaolin with 90% cement. For each the three binder system; 7 beams of the size 100 x 200 x 1500 mm were cast, the first beam known as control beam containing no fibres. The remaining 6 beams were cast using FRC containing a volume fraction of 1% 2% &3% PVA and basalt fibres, respectively. All 21 beams were tested to failure under three-point flexural loading. Experimental results showed that the addition of PVA fibres significantly improved the post-cracking flexural response compared to that of the basalt fibres. Beams with 3% PVA fibre volume showed deflection-hardening behaviour with an improvement in post-cracking flexural strength. Fareed Elgabbas et.al.,(2016) were aimed to determining the bond-dependent coefficient (k_b) and investigating the structural performance of newly developed Basalt fibre reinforced polymer (BFRP) bars in concrete beams. A total of six concrete beams reinforced with BFRP bars were built and tested up to failure. The test beams measured 200 mm wide, 300 mm high, and 3100 mm long. Ten 12mm and 16mm BFRP bars with sand-coated surfaces over helical wrapping were used. The beam specimens were designed and tested under four-point bending over a clear span of 2700mm until failure. The beam test results are discussed in terms of cracking behaviour, deflection, and failure modes. The test results yielded an average k_b of 0.76, which is in agreement with the CSA S6-14 recommendation of 0.8 for sand-coated bars. Xiaochun Fan and Mingzhong Zhang (2016) conducted the experimental study on basalt reinforced inorganic polymer concrete (IPC) beam which combines the specific characteristics of IPC and basalt reinforcement. The inorganic polymer blinder was made of fly ash, ground granulated blast-furnace slag and alkaline activating solution. The mechanical properties of IPC were measured and compared with those of reference ordinary Portland cement (OPC) concrete. The flexural behaviour of basalt reinforced IPC beam was investigated and compared to control steel-reinforced OPC concrete beam. The measured ultimate flexural capacity of basalt reinforced IPC beam was compared with the predicted value obtained using the guidelines for FRP-reinforced OPC concrete beam. Results indicated that elastic modulus of IPC was very close to OPC, while the compressive strength and flexural strength of IPC were around 80% of those of OPC.The IPC beam reinforced with basalt rebar exhibited a two-stage load-midspan deflection response that was different from control concrete beam due to the different mechanical properties of basalt and steel rebar's. The crack patterns in basalt reinforced IPC beam were found to be similar to control beam; however, the maximum crack width of basalt reinforced beam was approximately two times that of control beam. The guidelines for FRP-reinforced concrete beam were adequate for predicting the flexural strength of basalt reinforced IPC beams. Luigi Fenu (2016) studied the dynamic behaviour of cement mortars reinforced with both glass and basalt fibres are studied. The influence of the addition of both types of fibre on energy absorption and tensile strength at high strain-rate was investigated, and the performance of the two types of fibre-reinforced mortar was compared. For this aim, basalt and glass fibres with same diameter and length were used. Static tests in compression, tension and bending were first performed. Dynamic tests by means of a Modified Hopkinson Bar were then carried out in order to investigate how glass and basalt fibres affected energy absorption and tensile strength of the fibre reinforced mortar at high strain-rate. The Dynamic increase factor (DIF) was finally evaluated. The experimental results show that DIF is not significantly affected by the addition of basalt and glass fibres, while energy absorption at high strain rate is significantly increased by the addition of glass fibres and only slightly increased by the addition of basalt fibres. D.Fernando et.al, (2016) presented an experimental and theoretical investigation on understanding the behaviour of BFRP-strengthened timber sections. The experimental component of the study presented consists of 54 tensile specimens with and without Basalt fibre reinforced polymer (BFRP). In some of the specimens, holes were cut in the mid span to stimulate a defect. The experiential study showed that BFRP increases both the strength and stiffness of the timber specimens. Findings of an FE study of BFRP-strengthened timber specimens are also presented. Stress and strain distributions of the specimens, obtained from the FE study are presented and discussed. Based on the findings of the FE study, and idealized strain distribution is presented. The idealized strain distribution was then used to develop analytical models for an equivalent elastic modulus of the regions with defects. In addition, analytical models are also presented to predict the ultimate load carrying capacity of the pure timber and BFRP-strengthened timber specimens. The predictions agreed well with the experimental results. The analytical models were then used in Monte Carlo simulations to demonstrate the effectiveness of the BFRP strengthening. It was found that BFRP could yield significant benefits in terms of increasing the strength and stiffness for the timber sections with defects. TianyuXie and TogayOzbakkaloglu (2016) conducted experimental study on the axial compressive behaviour of concrete filled FRP tubes (CFFTs), prepared using different amounts of recycled concrete aggregate (RCA). Thirty six CFFTs were tested under axial compression. The effects of the RCA replacement ratio, specimen cross sectional shape, FRP type, and concrete strength were studied. The results suggest that the axial stress strain behaviour of CFFTs is affected by the amount of RCA, which particularly affects the ultimate axial strain and hoop rupture strain. For a given in-place concrete strength, an increase in RCA content leads to a decrease in compressive strength and an increase in ultimate axial strain of FRP-confined concrete. The results indicate that the, increased RCA content leads to a decrease in the hoop rupture strain of CFFTs. CFFTs manufactured with carbon FRP tubes instead of basalt FRP tubes and CFFTs with circular cross-sections instead of square cross-sectional shape and FRP type on the axial compressive behaviour of CFFTs vary with RCA content. Mehmet Emin Arslan (2016) investigated the fracture behaviour of basalt fibre reinforced concrete (BFRC) and glass fibre reinforced concrete (GFRC). In the experimental study three-point bending tests were carried out on notched beams produced using BFRC and GFRC with 0.5, 1.2 & 3 kg/m3 fibre contents to determine the value of fracture energy. Fracture energies of the notched beam specimens were calculated by analysing load versus crack month opining displacement (CMOD) curves by the help of RILEM proposal. In addition, micro structural analysis of the three components; cement paste, aggregate, basalt and glass fibre were performed based on the Scanning Electron Microscopy and Energy- Dispersive X-ray Spectroscopy examinations and analysis were discussed. The results showed that the effects of the fibre contents on fracture energy were very significant. The splitting tensile and flexural strength of BFRC and CFRC were improved with increasing fibre content whereas a slight drop in flexural strength was observed for high volume of fibre content. On the other hand, effect of effect of fibre addition on the compressive strength and modulus of elasticity of the mixtures were insignificant.

III. CLOSURE

The basalt fibers were used in the concrete works as reinforcing material and from the past research works it came to know that, the fibers are effective in respect of strength and durability. The main advantage of fibers is corrosion resistance and sustain for long duration. The basalt fiber effect was also studied in the recycle aggregated concrete and in that also the fibers efficiency was proved at best. Micro analysis was carried out on the basalt fiber concrete to examine the performance behavior. The author is expressing as few more studies are required to enhance the strength properties by using nano technology (by using nano materials) along with addition of fibers. The crack analysis can be performed by using Digital image processing.

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