Effect of Atmospheric Oxygen Plasma treatment on Bonding Characteristics of Basalt Fibre Reinforced Concrete

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Introduction:

The definition of fibre reinforced concrete is composite material containing of mixture of cement, mortar on concrete and discontinues, discrete uniformly dispersed suitable fibre materials. Fibre reinforced concrete has different properties and many advantages. The fibre is a small piece of reinforcing materials. Fibre reinforced concrete has different properties and many advantages. The fibre is a small piece of reinforcing material, with polymer molecules certain characteristics and properties. In form of circular or flats fibres have specific diameter and length the ratio between those two parameters is called as aspect ratio. The range of it is 30 to 150.

The fibre reinforced concrete contains fibrous materials, which helps to increases structural integrity; fibre reinforced concrete contains discrete fibres that are uniformly distributed randomly oriented manner. The fibre include steel fibres, glass fibres, synthetic fibres, the different characteristics of those fibres that influence the physical properties of FRC is based on the fibre properties, geometric distribution, orientation and densities.

Effect of fibre reinforced concrete:

The fibres are used to control the concrete, plastic shrinkage cracking and dry shrinkage cracking. The fibre reduce the permeability of concrete and thus reduce the bleeding of water, some fibre improve the impact strength, Abrasion and shorter resistant of concrete. The fibre should not increase the flexural strength of concrete, so it can not be the replacement resisting or structural steel reinforcement. The amount of fibre added on the concrete, mix is measured as the percentage, of total volume of the composition (concrete and fibre) termed as Vf. The Vf typically range from, 01% to 3.0% , Aspect ratio, fibre length (l) divided by fibre diameter d. In the case of fibre are in the non-circular cross section use equivalent diameter for calculating aspect ratio.

If the modulus of elasticity of fibre is higher than the matrix (concrete or mortar binder) they help to carry the load, by increasing strength of concrete. Increase the aspect ratio, of the fibre usually segments of the flexural strength and toughness of the matrix. In practices the fibres which are too long length, tend to ball in the mixing and create workability problems. Some recent research indicated that using fibres, in concrete has limited effect of impact resistance in concrete materials. That result also indicated, micro fibres have better impact resistance than the long stable fibres.

The using of textile fibres used in the structural application the following limitation the ageing properties, the fibourious materials bonding to the cement matrix, degradation chartersistics, to withstand against the critical environmental conditions.

The study ensures the bonding behaviour of basalt fibre to concrete matrix. The basalt fibre treated with automosperic oxygen plasma treatment, then test fibre pullout test, the parameter find out de bonding energy level, fibre pullout strength.

Material and Methodology:

Basalt raw fibre 50mm staple length, mould prepared the following parameter. 70mm height, 10 mm thickness, 50mm width. All the specimen are prepared by M20 concrete water curing done, 20 days, after curing specimen subjected to testing of fibre pullout.

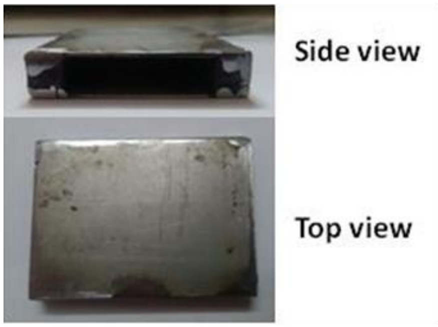

Figure. 1 Mould dimension for fibre pull out test
(10mm width, 50mm breath and 70mm height)

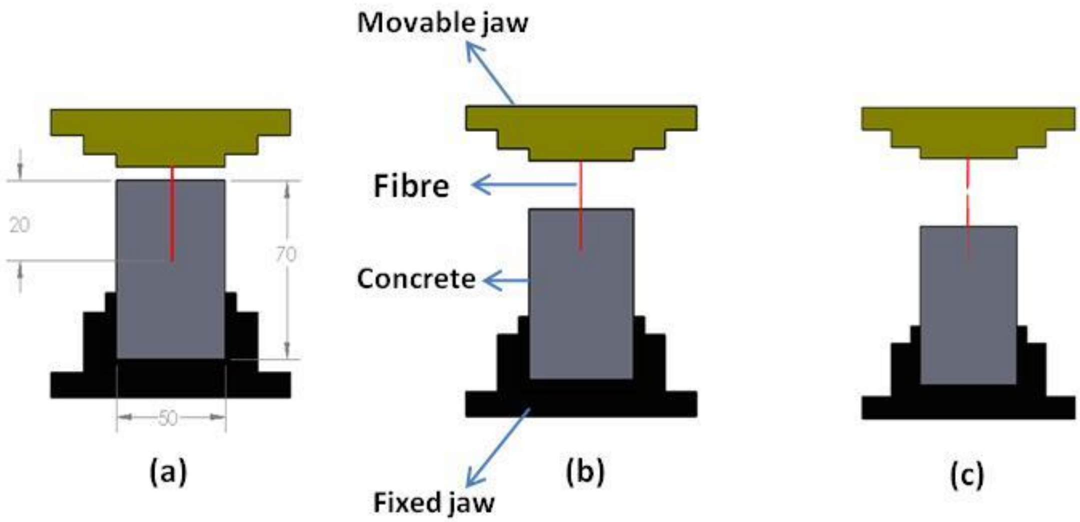

Figure. 2 Schematic diagramme of fibre pull out test
(a) Fibre fixed with top jaw (b) Fibre elongation stage and (c) Fibre breaks

The sample prepared 50 mm staple fibre, with 25mm embedded length and 20mm embedded length respectively. 30 numbers of specimens produced here, each of the sample subjected fibre pullout. Some samples fibres are breakable, so that specimens are rejected. Finally we get a result the following, summarised and tabulated.

Result and Discussion:

De bonding energy level in JM^{-2} of different staple length and embedded length of basalt fibre with Single fibre and fibres in the composite materials (Table No.1)

Sample fibre length	Embedded length	De bonding energy in J/m^2 for fibre untreated	De bonding energy in J/m^2 for fibre plasma treat	Improvement percentage
50 mm	25 mm	94.8	106.8	12.72
50 mm	20 mm	96.6	106.1	9.82
25 mm	15 mm	94.7	104.95	10.83
25 mm	10 mm	91.6	100.1	10.26

Pull out energy level in JM^{-2} of different staple length and embedded length of basalt fibre with single fibre and fibres in the composite materials (Table No.2)

Sample fibre length	Embedded length	Pull out energy in J/m^2 for fibre untreated	Pull out energy in J/m^2 for fibre plasma treat	Improvement percentage
50 mm	25 mm	284.06	317.23	11.49
50 mm	20 mm	268.10	294.01	9.66
25 mm	15 mm	153.43	168.65	9.92
25 mm	10 mm	148.88	164.33	10.38

Frictional Bonding strength in N/mm^2 of different staple length and embedded length of basalt fibre with single fibre (Table No.3)

Sample fibre length	Embedded length	Frictional Bonding strength in N/mm^2 for fibre untreated	Frictional Bonding strength in N/mm^2 for fibre plasma treat	Improvement percentage
50 mm	25 mm	1.185	1.254	5.82
50 mm	20 mm	1.112	1.198	7.73
25 mm	15 mm	1.125	1.193	6.04
25 mm	10 mm	1.196	1.272	6.35

Conclusion:

1) De bonding energy level in JM^{-2} of different staple length and embedded length of basalt fibre with Single fibre and fibres in the composite materials (Table No.1), embedded length of the fibre is increasing requirement of energy for de bonding also increasing.

2) De bonding energy level requirement increasing approximately 10% plasma treated fibre, comparing to the untreated fibres irrespectively of staple length and embedded length.

3) De bonding energy level in JM^{-2} (50 mm staple length, embedded length 25 mm) 106.8 JM^{-2} observed higher value comparing to other samples.

4) Pull out energy level in JM^{-2} of different staple length and embedded length of basalt fibre with single fibre and fibres in the composite materials (Table No.2) irrespective of staple and embedded lengths energy level requirement is approximately 10% increase treated and untreated samples.

5) The fibre pull out energy level in JM^{-2} (50 mm staple length, embedded length 25 mm) plasma treated 317.23 JM^{-2} observed higher values comparing to other samples.

6) The fibre De bonding energy level to compare pull out energy level, 50 mm staple length and embedded length of fibre (25mm,20mm) increase approximately 64.5 %, 25 mm staple length and embedded length of fibre (20mm,15mm) increase approximately 38.5% , Plasma treated fibre staple length play an important role for fibre pull out energy level requirement.

7) Frictional Bonding strength in N/mm^2 of different staple length and embedded length of basalt fibre with single fibre (Table No.3) is observed irrespective of staple length and embedded fibre plasma treated fibre improved approximately 6.00%.

8) Frictional Bonding strength 50mm staple length 25mm embedded length Plasma treated in 1.254 N/mm^2 samples is observed maximum comparing all other samples. So, embedded length is increasing frictional bonding strength is also increase.

Due to the plasma treatment the fibre surface roughness to be improved, and also creation of some functional groups to bonding rigidly with concrete matrix materials. The SEM analysis and FTIR analysis under study, which will ensure the proper reason of bonding strength improvement.

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