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Effect of Fibre Content and Aspect Ratio on the Permeability and Durability of Sustainable Concrete

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Abstract: The durability of concrete is a critical parameter governing the service life of structures, particularly under aggressive environmental exposure. The incorporation of recycled plastic fibres offers a sustainable approach to enhancing durability while addressing plastic waste management. This study experimentally investigates the influence of recycled plastic fibres on the sorptivity, water permeability, and chloride ion penetrability of M30 grade concrete. Fibres with varying volume fractions and aspect ratios were uniformly dispersed in the concrete matrix, and durability-related tests were conducted in accordance with relevant ASTM, DIN, and IS standards. The results indicate that fibre inclusion significantly modifies the pore structure of concrete, leading to reduced permeability and improved resistance to chloride ingress up to an optimum fibre content. Beyond the optimum dosage, fibre agglomeration adversely affects durability performance. The findings demonstrate that appropriately proportioned recycled plastic fibres can produce dense and durable concrete, contributing to sustainable construction practices without compromising performance.

Keywords: Concrete durability; recycled plastic fibres; sorptivity; water permeability; chloride ion penetration; sustainable concrete; fibre aspect ratio; permeability resistance; experimental evaluation.

I. INTRODUCTION

The main disadvantage of concrete is its low ductility and low resistance against cracking and its low tensile strength. If the cement matrix is reinforced with randomly or orderly distributed fibres. They act as crack arresters, which cause failure. Prevention of cracks improves static and dynamic properties of the concrete matrix. During last two decades through extensive research, a relatively new construction material is developed in construction field is termed as fibre reinforced concrete Reinforcing brittle concrete to improve their mechanical properties. A large number of researchers around the world have investigated the various aspects of fiber-reinforced composites (FRC).

The inclusion of fibre in concrete increases the ductility, improve the tensile strength, resistance to formation of cracks, toughness strength, and resistance to fatigue. Many types of fibres like steel, galvanized iron, glass, asbestos, nylon, polypropylene, polyester, waste plastic etc…can be used to produce fibre reinforced concrete. In the fibre reinforced concrete, the fibres are distributed randomly or in ordered manner in the concrete at the time of dry mixing, and thus improve the mechanical properties of concrete in all directions. Plastic is causing a tremendous environmental pollution. Many research works are carried out to use this waste plastic in a safe manner. In America and Europe, where millions tons of waste plastics was dumped in oceans like Atlantic and pacific has caused death of many marine lives.

In India, the plastic industry is growing phenomenally as it is used in all sectors like consumer goods, containers, and packaging construction etc. The demand is trebling every 10years, but it is less when compared to the world statistics of per capital consumption of plastics.The disposal of such waste plastics is a major challenge to the municipalities especially in the metropolitan cities and such plastic are non-biodegradable material which neither can be burned nor be used as filling low lying areas. Alternate ways of disposal is to recycle it as building material or road material. Fibre can impart some additional desirable qualities to concrete. This will certainly have good qualities compared to ordinary concrete.

II. LITERATURE REVIEW

P. B. Nagarnaik, R. N. Nibudey, A. M. Pande,D. K. Parbat[2013] [1], conducted an experimental study by using waste PET bottles as fibres in concrete for determining it's workability (slump, compaction factor), compressive, split tensile and flexural strength with two (2) aspect ratio's namely 35 and 50.

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They concluded that, the mechanical properties of concrete like compressive, splitting tensile and flexural strength are increased using waste PET bottles as fibres in concrete with 1% of fibres inclusion and aspect ratio of 50 were 7.35%, 24.91% and 24.105% for aspect ratio 50, over reference concrete (0% fibers). With inclusion of these fibres it is also seen that, concrete will show a ductile type behavior. Amit Rana [2], carried out an experimental investigation by using steel fibres in concrete, and conducted flexuralstrength test.

After the experimental work, he concluded that with inclusion of steel fibres in concrete would increase the flexural strength. A better flexural strength was found at 1 % steel fibreof volume fraction,hence increase of 1.1% flexural strength was obtained compare to control concrete. SalmetWidodo[2012] [3],have conducted an experimental investigation to study the fresh and hardened properties of SCC by using polypropylene fibres in fresh state, for determining its flowability, viscosity and passing ability of SCC as per EFNARC guidelines. Fibre content of 0%, 0.05%, 0.1% and 0.15% volume factions were added to concrete mixes and fresh characteristics were determined.

It was concluded that for a fibre added up to 0.10% by volume of concrete will show better results and the hardened properties such as compressive, split tensile and impact resistance increase with increase with percentage of fiber up to a 0.10% volume factions.T. Senthil Vadivel and M. Doddurani [4], conducted an experimental study by using waste plastic fibre in plain concrete and found that the increase in percentage of fibre content increases the mechanical properties of concrete. According to them, plastic fibre concrete (PFRC) are ecofriendly, non-hazardous and easily get dispersed in the concrete mix and it can be used as an effective plastic waste management practices. O Gencel et.al. [2011] [5], conducted an experimental study for determining the workability and mechanical properties of SCC by using monofilament polypropylene fibres. The fibre content at 3, 6, 9, and 12kg/m3 and cement content at 350 ad 450kg/m3 were studied. The quantities of super plastizers, fly ash and w/c ratio were kept constant at 1% of cement content, 120kg/m3 and 0.40 respectively. As the fibre content were increased, the air content of concrete has increased. It has been concluded that monofilament polypropylene fibres can be used at much lesser content than steel fibres. With inclusion of polypropylene fibres the hardened properties have increased. Kishore S Sable, Madhuri K Rathi [6], conducted an experimental work using steel fibres like straight types, hook ended and crimped steel in concrete for determining the mechanical properties of concrete with an aspect ratios of 50 and 80 and with fibre volume fraction of 2.5% by weight of cement. They observed that in case of hook ended and crimped fibre the shape helps to have good bond and anchorage in matrix which increases in strength. B Krishna Rao V Ravindra [2010] [7], an experimental work was carried out by using steel fibres in SCC with high volumes of class F fly ash, for determining the mechanical properties like compressive, flexural and split tensile strength of concrete. Along with addition of above mentioned fibres with aspect ratios of 15, 25 and 35 with three different fibre volume fractions viz. 0.5%, 1.0% and 1.5% are used. It was found that fibrevolume fraction of 1% having aspect ratio of 25 shows increased mechanical properties than normal SCC. It was observed that the workability characteristics of SCC increased with addition on high volume of fly ash. Y.L.Mo, Hemanth B Dhonde, Thomas T.C Hsu, John Vogel [2007] [8], have conducted an experimental study with addition of two different types of hooked steel fibres with variable amount to produce the self-consolidated fibre reinforced concrete (SCFRC). The fibre volume fractions were1.5% and 0.50% with 30mm and 60mm long fibres. It was observed that, the slump flow or stability of SCFRC was not effected by short fibres. But long steel fibres affected the filling and passing ability of SCFRC mix. P. B. Nagarnaik, R. N. Nibudey, A. M. Pande, D. K. Parbat [9], conducted an experimental study by using waste plastic fibres in concrete for determining it's flow and strength properties. The fibre content was varied from 0% fibre of volume fraction to 3% fibresIt was concluded that flow properties were effected but there was significant improvement at 1% of waste plastic fibre with compressive and split tensile strength increased by 4.30% and 11.21% respectively over control concrete. Further increase in percentage of fibre content resulted in reduction in strength. Kandasamy, R. Murugesan [2011][10], conducted a study on M20 grade concrete with inclusion of 0.5% of polythene fibers content by weight of cement and determined its mechanical properties The studyF concluded that the mechanical properties of concrete with addition of polythene fibre shows lower results in comparison with steel fibres. The increase in cube compressive strength and split tensile strength of concrete to an extent of 0.68% at 7 days and 1.63% respectively. Dr. Prahallada M.C and Dr. Prakash K.B [11], conducted an experimental investigations to study the strength and workability parameters of waste plastic fibre reinforced concrete with recycled aggregates with an aspect ratio of 50 and different percentages of waste plastic fibre. The volume fraction chosen were 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3%. It was concluded that addition of 1% waste plastic fibre reinforced concrete using recycled aggregates showed better strength and workability. Buquen Miao, et.al [2003] [12], conducted an experimental study for determining the workability and flexural strength of self compacting concrete by using steel fibres. Steel fibre content of 0%, 0.5%, 1.0% and 1.5% were included in concrete and successfully developed SFRC without bleeding and segregation. W/P ratio of 0.32 was fixed. After the experimental work, it was observed that with1% steel fibre content flexural strength of self compacting concrete would increase. Prahallada M. C, Prakash K. B [13] studied the behavior of concrete with addition of 0.5% of waste plastic fibres by volume with aspect ratio of 50 and flyash in different percentages as replacement of cement. From the test results it was observed that with addition of flyash up to 25% of cement replacement will have

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higher strength properties and good workability to waste plastic fibre reinforced concrete V.S.Tamilarasan, Dr.P.Perumal and R.J.Maheswaran[2012] [14], conducted a detailed experimental study to study the permeability characteristics. They replaced cement by GGBS in M20& M25 grade of concrete and studied its permeability characteristics by depth of penetration method. GGBS was used to replace the cement partially from 0 to 100% at increments of 5%. It was observed from test results that, with the partial replacement of cement by GGBS upto 60%, the permeability characteristics of concrete is decreased and the resistance to chemical attack is increased. Suresh Babu.R, Rakesh.A .J, Ramkumar .V.R [2013] [15], have conducted an experimental investigation for M25 and M50 grade concrete with addition of different percentage of glass fibre as 0.5, 1, and 1.5% for determining the compressive strength and permeability characteristics. From the experimental study it was noted that the inclusion of glass fibres in concrete, reduces the permeability index value and increase in compressive strength .Optimum percentage of fibres was 1.50% of glass fibres for both grades of concrete. SP Singh, AP Singh, MP Singh [2013] [16], studied the water permeability of fibre reinforced concrete with varied aspect ratios with constant 0.50% steel fibres content. They concluded that water permeability decrease significantly with an optimum aspect ratio of 42 and the compressive strength and split tensile strength are increased up to an extent of 25 % over plain concrete. A.P. Singh [2013] [17], did an investigation by using straight steel fibres with an aspect ratio of 65 to study the effects of fibre parameters on the water permeability and strength characteristics such as compressive and split tensile strengths. They tested the specimens after 7, 14 and 60 days. It was concluded that the permeability of concrete decreases significantly with the inclusion of steel fibres and it continues to decrease with increasing weight fractions of fibres.

Prahallada M.C and Prakash K.B [2014] [18], conducted a study on permeability characteristics of Waste plastic fibres reinforced concrete with the addition of different percentages of waste plastic fibres viz 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, and 1.5% by weight of cement. The Permeability test was done as per IS: 3085-1965 procedure It was observed that the coefficient of permeability decreases initially up to 0.5% waste plastic fibre beyond which the coefficient of permeability increases. Kartini K.1, Mahmud, H.B., Hamidah, M.S [2010] [19], conducted an investigation for M30 grade concrete with replacement of cement by RHA at 20% and 30% by weight with or without addition of super plasticizer. The initial surface absorption test was conducted.From the investigation it was observed that addition of up to 30% RHA can attain strength of 30 N/mm2 at 28 days ,can lower the water absorption and increase the durabilit KokSeng Chia, Min-Hong Zhang [2001] [20], conducted an experimental work on high-strength lightweight concrete with and without silica fume to determine the water permeability and chloride penetrability of high-strength light weight concrete using the rapid chloride penetrability and the observed chloride penetration depth determined by the immersion and salt ponding test. It was observed that the light weight concrete have higher resistance to water and chloride-ion penetration than the normal concrete. Kosmatka, S. H., B. Kerkhoff, et al. [21] reported that concrete made with high water cement ratios, shows a higher permeability index for the same duration of curing and the same curing temperature. It was observed that properly cured concrete have the lower permeability. Hence, it is important to specify the age at which the permeability is measured. NusretBozkurt, Salih Yazicioglu [22], have conducted an experimental investigation for structures located above the ground level using capillary water absorption (sorptivity) of concrete for determining the durability properties of the concrete.From test results a good correlation between sorptivity and strength values was observed.Mr. M K Maroliya et. al., ([2012][23], conducted an experimental investigation for determining the durability index of ultra-high strength reactive powder concrete (RPC) adopting Water Sorptivity test for evaluating the durability of RPC and cover zone concrete. RPC shows a good resistance to permeability indicating impermeable concrete. The sorptivity and porosity were also found to be depending on the amount of stratification and the materials being used. Dr. K. B. Prakash, Deepa A Sinha, Dr. A. K. Verma (2012) [24], have conducted an investigation for studying the properties of steel fibre reinforced concrete with ternary blends. It was observed from the test results that the water absorption and sorptivity of ternary blended steel fibre reinforced concrete has lower water absorption. Dr. F S Umrigar, Jayesh kumar Pitroda (2013) [25], have conducted the water absorption and sorptivity(capillary suction) test for measuring the water absorption rate with the fly ash as replacement in concrete. It was observed that the conventional concrete has lesser amount of water absorption rate and sorptivity than flyash replaced concrete.He concluded that the water absorption rate and sorptivity of M40concrete grade fly ash replaced concrete is more than M25 grade fly ash concrete.With replacement of flyash up to 10% in both the grades of concrete namely M25 and M40, showed lower rate of water absorption and sorptivity. Rushabh A. Shah, Jayesh kumar Pitroda (2013) [26], conducted the water absorption and sorptivity (capillary suction) test for measuring the water absorption rate with Pozzocrete as replacement in concrete. The experimental results showed increase in water absorption of 4.83%, 3.85%, 4.14% for P40, P60, and P100 respectively with respect to control mix. P. B. Nagarnaik, R. N. Nibudey, A. M. Pande, D. K. Parbat(2014) [27], conducted an experimental study by using waste PET bottles as fibres in concrete for determining it’s compressive strength and sorptivity test with two (2) aspect ratio’s namely 35 and 50. It was observed that the strength and water absorption sorptivity was found to better at 1% volume fraction of plastic fibers with aspect ratio of 50 for M20 grade

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Amr A. El Hefnawy, EsamElawady, Rania A. F. Ibrahim [2014] [28], conducted an experimental work to investigate the compressive strength, permeability and sorption and the relation with durability of concrete in the presence/absence of silica fume and also the effect of cement content at two different levels; 350 and 450kg/m^3. It was observed that that concrete sorptivity decreases, for specimens cured in water for 28 days at 20°C. Concrete containing Silica fume showed higher strength and lower sorptivity and permeability.

Srinivasa Rao P, Chandramouli K, SeshadriSekhar T, Pannirselvam N, Sravana P [2010] [29], have conducted an experimental investigation using glass fibres with varying percentage from 0.03%, 0.06% and 0.1%for M20 grade concrete to determine its durability characteristics such as chloride ion penetrability test. Chloride permeability of glass fibre reinforced concrete was conducted at different curing periods of 90, 180, 365 and 720 days which shows lesser permeability with inclusion of 0.1% of glass fibres by volume fraction when compared conventional concrete and there is decrease of permeability by 17.59%, 25.80% at 90,720daysdays respectively.

III. EXPERIMENTAL WORK

Materials such as cement, fine aggregate, coarse aggregate, super plasticizer as water reducing agent, waste plastic fibre and water are tested to check their suitability and proportion in workability and mix design. The test results are given in detail.

3.1 Materials Used

Cement

Ordinary Portland cement, 53 grade, BIRLA TECH by brand name confirming to IS 8112- 1989 is used for the investigation throughout.

Table 3.1 Results of Test on Cement

Sl. No	Test	Experimental Values	Suggested values as per IS 12269-1987
1.	Specific Gravity	3.15	3.10 -3.15
2.	Normal Consistency	30%	30% - 35%
3.	Setting Time Initial Final	 160 minutes 310 minutes	 <30 minutes <600minutes
4.	Compressive Strength 3 days 7 days 28 days	30 N/mm2 44.5 N/mm2 57.5 N/mm2	>27 N/mm2 >37 N/mm2 >53 N/mm2
5.	Soundness	1mm	<10mm

Fine Aggregate

Natural river sand is procured from nearby district Mandya for the current investigation. The sand is tested as per IS 383-1970 for the following parameters.

Table 3.2 Results of Test on Fine Aggregate

Sl. No	Property	Value
1.	Specific Gravity	2.54
2.	Fineness modulus/ Grade	2.90/Zone II
3.	Silt Content	2.12%
4.	Moisture Content	Nil
5.	Water Absorption	0.60%

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Coarse Aggregate

Coarse aggregate of size 10mm and below is obtained from a local quarry in the present work.

Table 3.3 Results of test on Coarse Aggregate

Sl. No.	Properties	Test Results
1.	Specific Gravity	2.53
2.	Moisture Content	Nil
3.	Water Absorption	0.15%
4.	Crushing Value	22%
5.	Impact Value	15%

Waste Plastic Fibres

Waste plastic used in this investigation is obtained from plastic flush doors. One particular brand of plastic sheets were obtained and used for all experiments. These sheets are manufactured in Coimbatore, Tamilnadu and supplied to all over south India. As per the dealers 10 to 15% of the production gets damaged and rejected in the process of transportation and fixing. The rejected and damaged sheets are cut into fibres and used in the present work. The physical properties of the plastic fibres are listed in table 3.4.

Table 3.4 Physical properties of the plastic fibres

Sl. No	Properties	Value
1.	Thickness	0.7mm
2.	Width of Fibre	5 mm
3.	Density	1.152g/cm^3
4.	Length	Cut as per aspect Ratio

3.5 Chemical Admixture

A new generation super plasticizer by brand name MASTER GLENIUM SKY 8233, a produce of BASF Chemicals is used in the present work. It is high range water reducing retarding super plasticizer. It contains no chloride or calcium chloride based ingredients and hence does not promote corrosion. Table 3.5 gives the manufacturer's specification of MASTER GLENIUM SKY 8233. Over dosage will lead to prolonged setting times, loss of workability and increase plastic shrinkage.

Table 3.5 Specification of MASTER GLENIUM SKY 8233.

Sl. No	Properties	Value
1.	Colour	Light Brown liquid
2.	pH	>6
3.	Specific Gravity	1.08
4.	Chloride ion content	<0.2%
5.	Solid Content	<30% by weight
6.	Test Certification/Approval	ASTM C494 Type F EN 934-2T31/3.2 IS2645:2003 IS9103:1999

3.6 Water

Ordinary tap water, free from organic matter and salt at room temperature is used in the present work.

3.7 Mix Design

Mix design is carried out for M 30 grade of concrete as per IS 10262: 2009 for the test results given in the tables for moderate exposure condition for a slump of 100mm.

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Table 3.6 Mix proportion

Material	Mass
Cement	392Kg
Fine Aggregate(Zone-II)	934Kg
Coarse Aggregate(10mm down size)	827Kg
Water	183 lit
Super plasticizer	2.75Kg

C: FA: CA: W=1:2.39:2.11:0.45

IV. PERMEABILITY

It is the property of the material which allows the fluids to pass through it. It may be due to pressure head or capillary action. The factors that affect the permeability are the viscosity of the fluid, pore structure of the concrete, age of concrete, type and duration of curing, admixtures used, use of fibres etc. some of the standard methods of testing the permeability are

- Sorptivity test for water absorption by capillary action as per ASTM C 1585 – 2004
- Water permeability to check the water flow under standard pressure head as per code DIN: 1048 Part (V) – 1987
- Rapid Chloride Penetration test (RCPT) to check the chloride ion flow as per ASTM C 1202- 2003
-

4.1 Sorptivity of Waste Plastic Fibre Reinforced Concrete

This test has been carried out to determine the rate of absorption of water (Sorptivity) by capillary suction when exposed surface of sample comes in contact with water. In the present study, the cylinders having dimensions 150 mm dia. x 300mm height were casted and then cored to a disc of 100 ± 6mm diameter with 50±3mm thick were used for absorption (sorptivity) test with technical reference as ASTM C 1585-2004 and the test was performed on prepared concrete specimens at the age 28 days Table 4.1shows the results of water absorption at 6^{th} hr. and 8^{th} day AR 50 and 70 verses various percentages of fibres and aspect ratios.

Table 4.1 water absorption at 6^{th} hr. and 8^{th} day AR 50 and 70

Specimen designation	%age fibres added	Absorption @6hr. in mm/sq. sec	Absorption @8day in mm/sq. sec
A1(REF)	0.00	0.36	0.11
Aspect ratio – 50			
A2	0.25	0.42	1.0
A3	0.50	0.307	0.797
A4	0.75	0.337	1.021
A5	1.00	0.341	1.074
A6	1.25	0.407	1.215
A7	1.50	0.586	1.231
Aspect ratio – 70			
B2	0.25	0.4147	1.0670
B3	0.50	0.2866	1.0044
B4	0.75	0.3948	1.0782
B5	1.00	0.4427	1.2874
B6	1.25	0.6557	1.3440
B7	1.50	0.5422	1.3455

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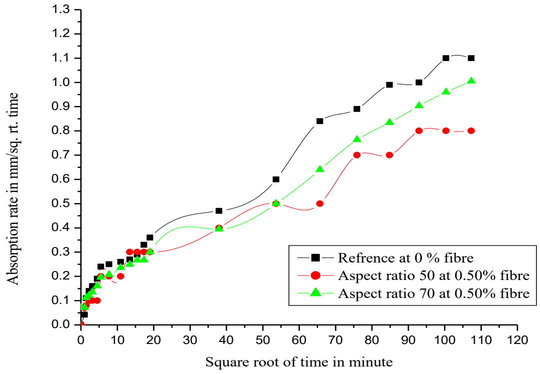
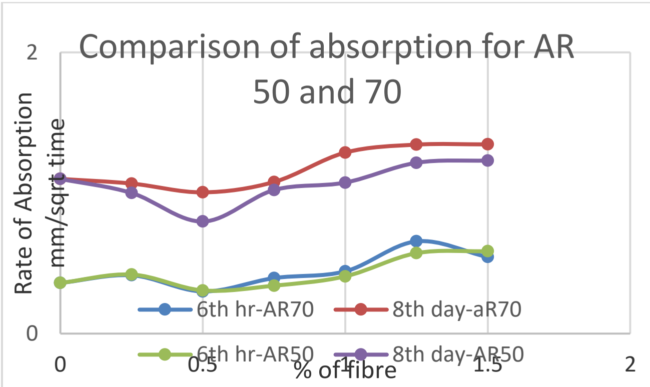


Fig 5 Absorption rate at 0.50% fibre with Aspect ratio – 50 and 70



4.1.1 Observations

Water absorption increases linearly with increase in time. For both aspect ratios of 50 and 70, 0.5 % of fibre is found to be optimum which absorbs least water through capillary action. Rate of absorption increases at a higher rate after 1% of addition of fibre, hence not recommended.

4.2 Water permeability- As per German standard DIN 1048-Part (V), Section 3.6

The water permeability can be measured in two ways viz. steady state and non - steady state water permeability. The coefficient of permeability is calculated by maintaining a constant pressure head and temperature for saturated flow, flowing in the concrete. Therefore unit for water permeability is $m^3/(m^2.s)$ or m/s.

The Darcy's Law is applied only for steady state of liquid flows. It was observed by many investigators that steady state flow conditions could not be achieved in concrete mixes having low permeability even after subjecting the test samples to pressures as high as $5kg/cm^2$ for a test period extending up to several weeks. Hence, some of researchers/investigators have used the depth of penetration method to determine the water permeability of concrete.

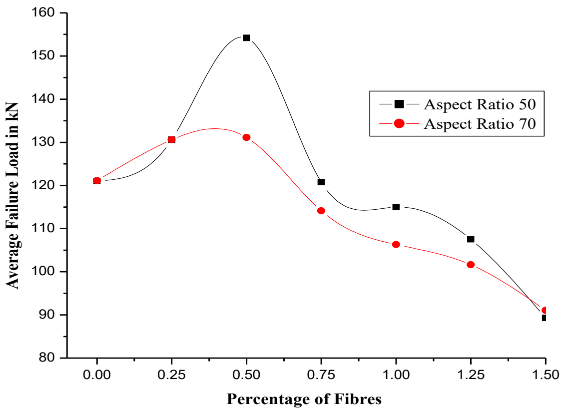


Fig 6 Percentage of Fibres V/S Failure Load for Aspect ratio 50 and 70

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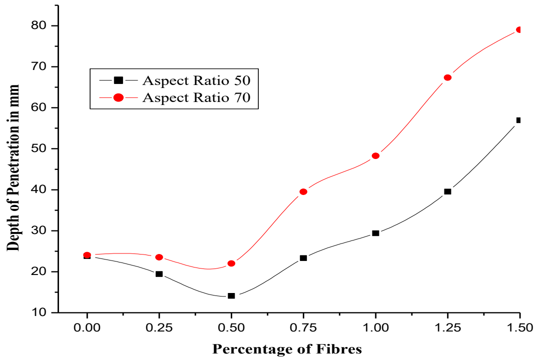

Fig7 Percentage of Fibres V/S Depth of Penetration for Aspect ratio 50 and 70

4.2.2 Observations

The permeability of concrete is found to decrease initially up to an addition of 0.5%of fibres. Beyond this specimens become more permeable and allow more fluid inside. This is found to be the same in aspect ratio 50 as well as 70. The concrete with aspect ratio 50 and % of fibre 0.5 is found to be most impermeable. Hence, it can be considered from the results that 0.5% and aspect ratio 50 are optimum values.

4.3 Rapid Chloride ion Penetration Test (RCPT):

The rapid chloride ion permeability test (RCPT) was considered to be a standard test method for rapid determination of the chloride ion permeability of the concrete by the American Association of State Highway and Transport Officials as AASHTO T277 in 1989 and subsequently as ASTM C 1202. This test is conducted for the determination of resistance to penetration of chloride ions in concrete. The RCPT method is a fastest method and used in quality control purposes.

4.3.1 General – ASTM C 1202

This method is widely adopted to ascertain the quality of concrete all over the world. The tests are performed on the specimens cured for 28 days in water. Cylindrical specimens of 100mm diameter and 50mm height are cored out from standard cylinders of size 150 mm diameter and 300 mm height. Chloride ion can penetrate the concrete by hydrostatic pressure, capillary action or diffusion. The rate of ingress of chloride ions into concrete depends on pore structure of concrete which intern depends on age of concrete, method of curing, construction practice, materials used and water cement ratio. The specimens re subjected to a 60VDC voltage for 6 hours . One reservoir is filled with 3.0% NaCl solution and another reservoir with 0.3 M NaoH solution. The total charges passed are determined at intervals over the duration.

4.3.2 Calculations

A minimum of 3 samples have to be tested and the average value should be considered. However, as per code if the values differ by more than 29%, such values must be ignored. The average current flowing through one cell is determined using trapezoidal formula,

$$Q = 900\ (I_0+2I_{30}+2I_{60}+2I_{90}+2I_{120}+\ldots+2I_{300}+2I_{330}+I_{360})\ /1000$$

Where;

Q = Current flowing through one cell (coulombs)
I_0 = Current reading in amperes immediately after voltage is applied
I_{30} = Current reading in amperes at 30 minutes after voltage is applied
I_{360}= Current reading in amperes at 6^{th} hour/360minutes after voltage is applied

Table 7 Quality of concrete was determined as per the ratings below.

Charges passed (Coulombs)	Chloride ion Penetrability	W/C ratio
>4000	High	>0.6 (Low strength Concrete)
2000-4000	Moderate	0.4 to 0.5 (Moderate strength)
1000 - 2000	Low	<0.4 High Strength
100 - 1000	Very Low	Polymer concrete Latex-modified
<100	Negligible	Polymer concrete/polymer impregnated

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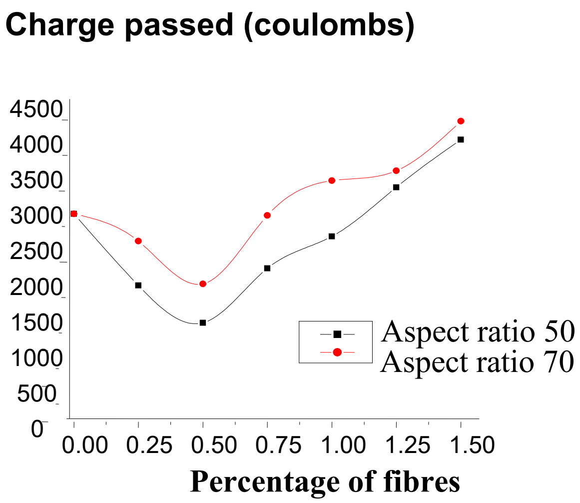

Fig 8 Details of Chloride ion penetration for various % of fibres for Aspect ratio 50 and 70

4.3.3 Observations

Increase in percentage of fibres decreases chloride ion penetrability initially up to 0.5% beyond which passability increases. The trend is same in both aspect ratios of 50 and 70. It is observed that aspect ratio 50 is more efficient in resisting the permeability than 70. As per the ASTM standards, the quality of concrete becomes better as the pass ability is changed from moderate to low. The concrete becomes more permeable as the percentage of fibres increase.

Hence, from all permeability tests it can be concluded that the 0.5 % of fibres will efficiently resist the permeability of concrete, make it more impermeable.

V. CONCLUSION

From the tests and observations, it can be concluded that the waste plastic fibres can be used efficiently upto 0.5%by volume of concrete. Sorptivity, water permeability as well as RCPT values are found to be better at aspect ratio of 50 and 0.5% of fibre, Concrete becomes dense, impermeable and durable and can efficiently be used at the above percentages.

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