International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

Vol.10, Issue.2, 2022
March-April.

RESEARCH ARTICLE

ISSN: 2321-7758

STRENGTH CHARACTERISTICS OF STEEL FIBRE REINFORCED CONCRETE PRODUCED WITH SELF CURING TECHNIQUES

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DOI: 10.33329/ijoer.10.2.1

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ABSTRACT

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cementatious material, aggregate and water and by adding some special self-curing ingredients and fibres. Curing is one of the major parameter which helps in improving water retention capacity of concrete which in turn helps in developing the microstructure of the concrete. Properly cured concrete has improved durability and surface hardness, and is less permeable. Internal curing is "supplying water throughout a freshly placed cementitious mixture using reservoirs, via pre-wetted lightweight aggregates or superabsorbent polymers, that readily release water as needed for hydration or to replace moisture lost through evaporation or self-desiccation". This study investigates strength characteristics of steel fiber reinforced concrete produced with self-curing techniques. The various parameters are studied for a period of 28 days curing [Air curing or water curing as the case may be.] The strength parameters namely compressive strength, split tensile strength, flexural strength and shear strengths are determined using SAP and pumice aggregate.

Key words: Self curing concrete, water retention, hydration, absorption, light weight aggregates, permeable pores, internal curing, super absorbing polymers, autogenous shrinkage, etc.

1 Introduction.

The **ACI-308** states that "internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water". Conventionally, curing means creating conditions such that water is not lost from the surface i.e., curing is taken to happen 'from the outside to inside'. In contrast, 'internal curing' is allowing for curing 'from the inside to outside' through the internal reservoirs (in the form of saturated lightweight fine aggregates, superabsorbent polymers, or saturated wood fibres) created.

The basic concept of this technology is to provide water for concrete, so that it can continue the curing process on its own. This is done by embedding the water inside the materials used to make concrete. If the water just added as mixing water this would lead to many other quality related problems, such as bleeding, segregation, loss of strength etc. Therefore, a special material shall be used so that some of the water can be hidden into the material. This water will be released into the concrete over time after the concrete has been placed in the structure and hardened. By doing this the hardened concrete will be able to undergo continuous curing for a long time, which will promote towards a better hydration product.

However, external curing may not be feasible in some circumstances due difficult access to some parts of the structure, and besides it is always time-consuming, labor-intensive and ultimately expensive. In addition, when curing water is provided with the purpose to compensate for internal drying in the case of concrete mixtures with low water-to cement ratio (w/c), external curing may not be efficient due to the tight microstructure of these mixtures, which limits the penetration depth of the curing water to the near-surface zone only. Therefore, the internal curing method has been developed recently as an effective technique for shrinkage mitigation [1, 2]. In this method, internal water reservoirs are introduced into the concrete mixture. These reservoirs can absorb significant amounts of water either before or during mixing and release the water gradually during concrete hardening. The released water will contribute to restore part of the water which has been lost through internal or external drying. The reservoirs include most commonly porous lightweight aggregates (LWA) [1-14], superabsorbent polymers (SAP) [15, 16], wood fibers [17] and recycled aggregates [18].

The influence of the initial moisture content of lightweight aggregate on internal curing [19] has beneficial aspects of increased hydration which leads to higher compressive strength, reduced water absorption, and reduced electrical conductivity (permeability). Further, these benefits include reduced autogenous shrinkage [20] and a lower propensity for early-age cracking.

2. Materials used.

- **Cement:** Ordinary Portland cement [OPC]-53 grade is used throughout the experimental programme. The specific gravity is found to be 3.15 and cement is conforming to IS: 12269 – 1987.
- **Fine aggregate:** Natural river sand is used in this experimentation programme with specific gravity 2.54 and confirming to zone II of IS: 383-1970.
- **Coarse aggregate:** Locally available angular crushed aggregates having size 20 mm and lesser size conforming to IS: 383-1970 with specific gravity 2.63 is used.
- **Water:** Potable water fit for drinking with a pH 7 is used.
- **Steel fibres:** Flat crimped steel fibres with aspect ratio 35, density 7850 kg/m^3 and ultimate tensile strength 1395 MPa are used. [Figure 1.]

Fig. 1: Steel fibers. Fig. 2: SAP

- **Superabsorbent Polymer:** Sodium salt of polyacrylic compound is used as superabsorbent polymer which has chemical formula; $[CH_2\text{-}CH(COONa)\text{-}]_n$. [Figure 2.]
- **Pumice stone aggregate:** Pumice stone aggregate in dry state [Fig. 3] and wet state [Fig. 4] which is a light weight aggregate having specific gravity less than one with density 0.25 g / cm^3 is used as partial replacement of coarse aggregate.

Fig.3: Dry Pumice Fig.4: Wet Pumice

3. Experimental procedure

The mix proportion for M30 grade concrete as per mix design as per IS code: 10262 – 2009 is found to be 1:1.55:2.74 with w/c ratio 0.45. Required quantity of cement, fine aggregates, coarse aggregates are dry mixed. Then the known quantity of steel fibers [2% by volume fraction] are added to the dry mix and once again mixed in dry condition. Before adding water to the mix, Superabsorbent polymer having percentages 0%, 0.1%, 0.2%, 0.3% and 0.4% by weight of cement for different sets is added to cement in dry condition. The additional quantity of water needed for different percentages of SAP is computed and is added during mixing along with the water requirement as per water-cement ratio.

In another case, the natural coarse aggregate is partially replaced by Pumice stone aggregates which are used as self-curing agents having percentages such as 0%, 10%, 20%, 30%, 40% and 50%. Pumice stone aggregates are used in concrete with soaking [wet state] in water and without soaking [dry state]. The specimens' caste using dry pumice stone aggregates [without soaking in water] are cured in water; whereas saturated pumice stone aggregates [with soaking in water] specimens are air cured for a normal period of 28 days. Pumice stone aggregates are saturated for a period of 60 to 90 minutes before adding to the mix.

Required quantity of water is added to the above said cases of dry mix. This fresh green concrete is placed in three different layers in the moulds which are thoroughly oiled. The moulds are vibrated by keeping them on table vibrator. Hand compaction is also adopted simultaneously. After compaction the specimens are covered by wet gunny bags. The specimens are demoulded after 15±0.5 hours and transferred to curing process either in water curing or air curing as the case may be. After 28 days curing period under normal temperature, the specimens are tested for their respective strength parameters.

4 Test results:

4.1 Compressive strength test results:

Table 1, 2 and 3 give the compressive strength tests results of steel fiber reinforced concrete with SAP and pumice aggregates. Figure 7 and 8 show the variation of compressive strength.

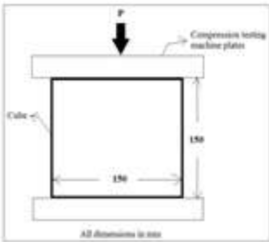

Fig. 5: Line diagram of cube. Fig. 6: Testing of cube.

Table 1: Compressive strength test results of concrete with SAP.

Percentage addition of superabsorbent polymer	Average compressive strength (N/mm^2)	Percentage increase or decrease of compressive strength w.r.t. reference mix.
0 [Ref.]	33.03	---
0.1	34.81	+5.36
0.2	36.00	+8.96
0.3	37.78	+14.35
0.4	34.00	+2.91

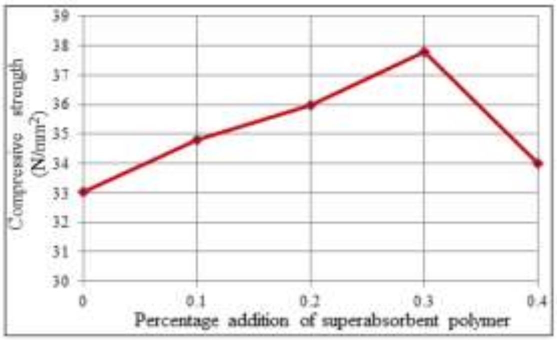

Fig. 7: Variation of compressive strength of concrete with SAP.

Table 2: Compressive strength test results of concrete with wet pumice aggregates. [with soaking]		
Partial replacement of coarse aggregates by pumice aggregates (%)	Average compressive strength (N/mm^2)	Percentage increase or decrease of compressive strength w.r.t. reference mix.
0 [Ref.]	33.04	---
10	33.48	+1.36
20	33.78	+2.27
30	34.22	+3.60
40	32.00	-3.12
50	31.56	-4.45

Table 3: Compressive strength test results of concrete with dry pumice aggregates. [without soaking]		
Partial replacement of coarse aggregates by pumice aggregates (%)	Average compressive strength (N/mm^2)	Percentage increase or decrease of compressive strength w.r.t. reference mix.
0 [Ref.]	33.04	---
10	34.52	+4.51
20	34.96	+5.84
30	35.63	+7.87
40	33.04	+0.03
50	32.00	-3.12

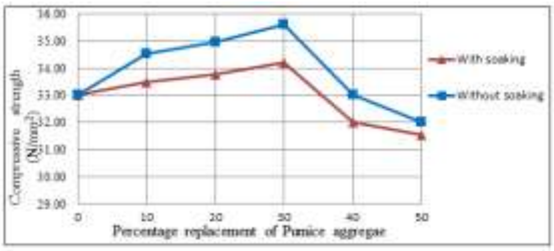

Fig. 8: **Variation of compressive strength of concrete with pumice aggregates.**

4.2 Split tensile strength test results:

Table 4, 5 and 6 give the split tensile strength tests results of steel fiber reinforced concrete with SAP and pumice aggregates. Figure 11 and 12 show the variation of compressive strength.

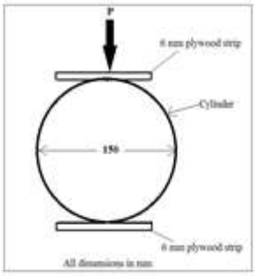


Fig. 9: Line diagram of cylinder. Fig. 10: Testing of cylinder.

Table 4: Split tensile strength test results of concrete with SAP.		
Percentage addition of superabsorbent polymer	Average split tensile strength (N/mm^2)	Percentage increase or decrease of split tensile strength w.r.t. reference mix.
0 [Ref.]	3.11	---
0.1	3.44	+10.61
0.2	3.68	+18.33
0.3	3.92	+26.05
0.4	3.02	-2.89

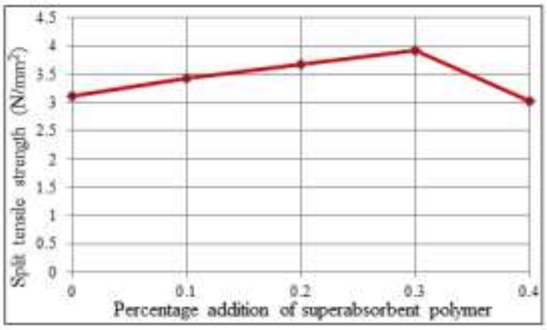

Fig. 11: **Variation of split tensile strength of concrete with SAP.**

Table 5: Split tensile strength test results of concrete with wet pumice aggregates. [with soaking]		
Partial replacement of coarse aggregates by pumice aggregates (%)	Average split tensile strength (N/mm^2)	Percentage increase or decrease of split tensile strength w.r.t. reference mix.

0 [Ref.]	3.11	---
10	3.18	+2.25
20	3.46	+11.25
30	3.61	+16.08
40	3.30	+6.11
50	2.90	-6.75

Table 6: Split tensile strength test results of concrete with dry pumice aggregates. [without soaking]

Partial replacement of coarse aggregates by pumice aggregates (%)	Average split tensile strength (N/mm^2)	Percentage increase or decrease of split tensile strength w.r.t. reference mix.
0 [Ref.]	3.11	---
10	3.42	+9.97
20	3.70	+18.97
30	3.75	+20.58
40	3.46	+11.25
50	2.92	-6.11

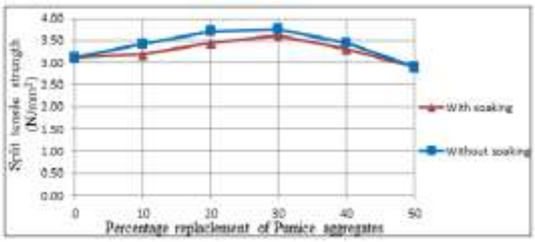

Fig. 12: **Variation of split tensile strength of concrete with pumice aggregates.**

4.3 Flexural strength test results:

Table 7, 8 and 9 give the flexural strength tests results of steel fiber reinforced concrete with SAP and pumice aggregates. Figure 15 and 16 show the variation of flexural strength.

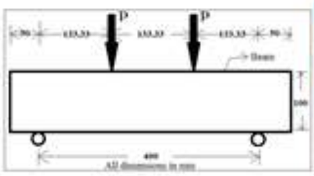

Fig. 13: Line diagram of beam. Fig. 14: Testing of beam.

Table 7: Flexural strength test results of concrete with SAP.

Percentage addition of superabsorbent polymer	Average flexural strength (N/mm^2)	Percentage increase or decrease of flexural strength w.r.t. reference mix.
0 [Ref.]	5.40	---
0.1	5.47	+1.30
0.2	5.80	+7.40
0.3	6.13	+13.52
0.4	5.27	-2.41

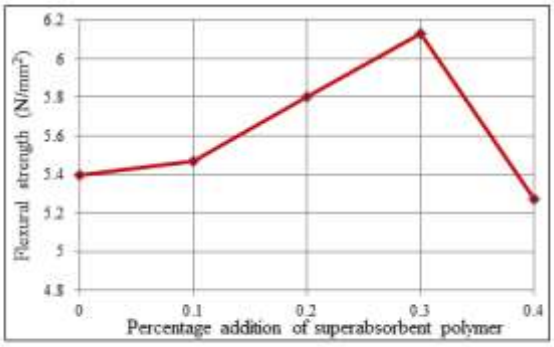

Fig. 15: **Variation of flexural strength of concrete with SAP.**

Table 8: Flexural strength test results of concrete with wet pumice aggregates. [with soaking]

Partial replacement of coarse aggregates by pumice aggregates (%)	Average flexural strength (N/mm^2)	Percentage increase or decrease of flexural strength w.r.t. reference mix.
0 [Ref.]	5.40	---
10	5.87	+8.70
20	6.13	+13.52
30	6.67	+23.52
40	5.60	+3.70
50	4.93	-8.70

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Vol.10, Issue.2, 2022
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Table 9: Flexural strength test results of concrete with dry pumice aggregates. [without soaking]		
Partial replacement of coarse aggregates by pumice aggregates (%)	Average flexural strength (N/mm^2)	Percentage increase or decrease of flexural strength w.r.t. reference mix.
0 [Ref.]	5.40	---
10	6.13	+13.52
20	6.53	+20.93
30	6.80	+25.93
40	6.40	+18.52
50	5.20	-3.70

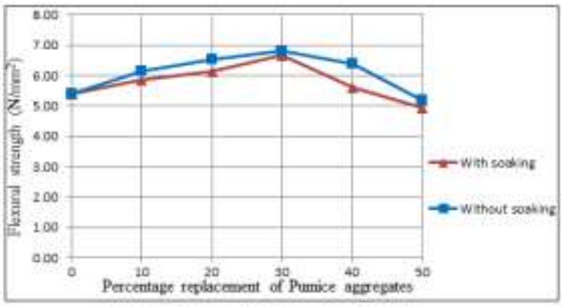

Fig. 16: **Variation of flexural strength of concrete with pumice aggregates.**

4.4 Shear strength test results:

Table 10, 11 and 12 give the shear strength tests results of steel fiber reinforced concrete with SAP and pumice aggregates. Figure 19 and 20 show the variation of shear strength.

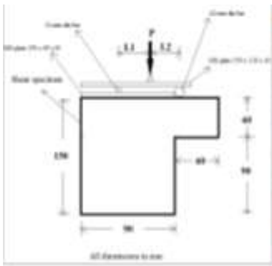

Fig. 17: Line diagram L-specimen. Fig. 18: Testing of shear specimen

Table 10: Shear strength test results of concrete with SAP.		
Percentage addition of superabsorbent polymer	Average shear strength (N/mm^2)	Percentage increase or decrease of shear strength w.r.t. reference mix.
0 [Ref.]	6.48	---
0.1	6.94	+7.10
0.2	7.31	+12.81
0.3	8.06	+24.38
0.4	6.39	-1.39

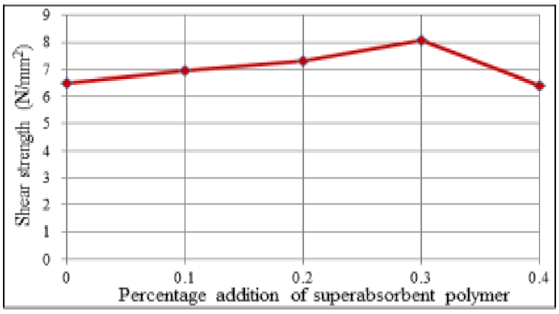

Fig. 19: **Variation of shear strength of concrete with SAP.**

Table 11: Shear strength test results of concrete with wet pumice aggregates. [with soaking]		
Partial replacement of coarse aggregates by pumice aggregates (%)	Average shear strength (N/mm^2)	Percentage increase or decrease of shear strength w.r.t. reference mix.
0 [Ref.]	6.48	---
10	6.57	+1.39
20	7.04	+8.64
30	7.50	+15.74
40	6.30	-2.78
50	5.93	-8.49

Table 12: Shear strength test results of concrete with dry pumice aggregates. [without soaking]

Partial replacement of coarse aggregates by pumice aggregates (%)	Average shear strength (N/mm^2)	Percentage increase or decrease of shear strength w.r.t. reference mix.
0 [Ref.]	6.48	---
10	6.94	+7.10
20	7.22	+11.42
30	7.68	+18.52
40	7.13	+10.03
50	6.11	-5.71

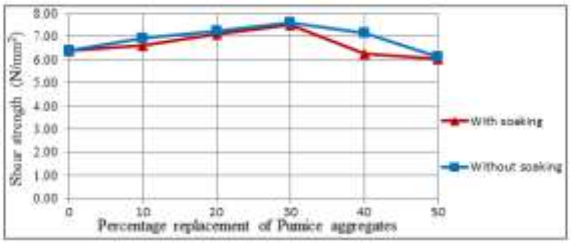

Fig. 20: **Variation of shear strength of concrete with pumice aggregates.**

1.4.5 Impact strength test results:

Table 13, 14 and 15 give the impact strength tests results of steel fiber reinforced concrete with SAP and pumice aggregates. Figure 23 and 24 show the variation of shear strength.

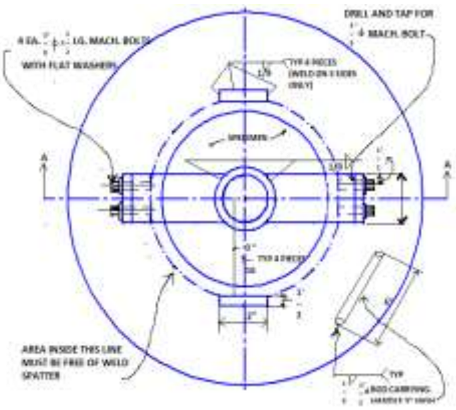

Fig. 21: Plan view of impact test.

Fig. 22: Schruders impact testing machine.

Table 13: Impact strength test results of concrete with SAP.

Percentage addition of superabsorbent polymer	Average impact strength for first crack (N-m)	Average impact strength for final failure (N-m)	Percentage increase or decrease of impact strength for final failure w.r.t. reference mix.
0 [Ref.]	899.07	961.31	---
0.1	912.90	995.89	+3.60
0.2	968.23	1023.56	+6.48
0.3	1203.37	1237.95	+28.78
0.4	975.15	1030.47	+7.19

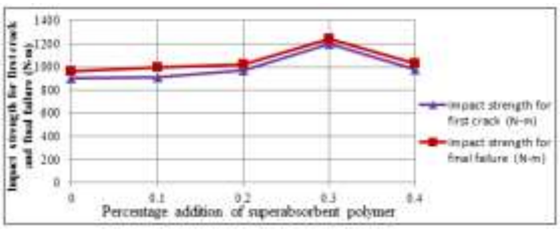

Fig. 23: **Variation of impact strength of concrete with SAP.**

Table 14: Impact strength test results of concrete with wet pumice aggregates. [With soaking]

Partial replacement of coarse aggregates by pumice aggregates (%)	Average impact strength for first crack (N-m)	Average impact strength for final failure (N-m)	Percentage increase or decrease of impact strength for final failure w.r.t. reference mix.
0 [Ref.]	899.07	961.31	---
10	940.57	1009.73	+4.97
20	995.89	1078.89	+12.23
30	1141.13	1244.87	+29.50
40	1016.64	1092.72	+13.67
50	982.06	1030.47	+7.19

Table 15: Impact strength test results of concrete with dry pumice aggregates. [Without soaking]

Partial replacement of coarse aggregates by pumice aggregates (%)	Average impact strength for first crack (N-m)	Average impact strength for final failure (N-m)	Percentage increase or decrease of impact strength for final failure w.r.t. reference mix.
0 [Ref.]	899.07	961.31	---
10	975.15	1023.56	+6.48
20	1016.64	1099.63	+14.39
30	1161.88	1265.62	+31.66
40	1044.31	1099.63	+14.39
50	988.98	1051.22	+9.35

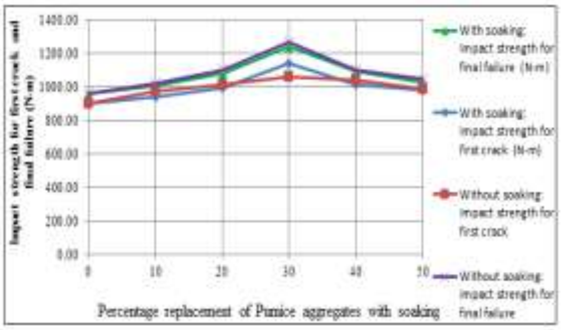

Fig. 23: **Variation of impact strength of concrete with pumice aggregates.**

5. Observations and discussions.

Based on the experimentations conducted, following observations are made.

1. Compressive strength of steel fiber reinforced concrete with superabsorbent polymer shows an increasing trend as the percentage of superabsorbent polymer in it increases up to 0.3%. A compressive strength of 37.78 MPa is obtained when 0.3% superabsorbent polymer is used. After 0.3% addition of superabsorbent polymer, compressive strength shows a decreasing trend. The percentage increase in the compressive strength is found to be 14.35% when 0.3% of superabsorbent polymer is added as compared to reference concrete.
2. Compressive strength of steel fibre reinforced concrete produced by replacing coarse aggregates by soaked pumice aggregates goes on increasing up to 30% replacement. There after the compressive strength decreases. A compressive strength 34.22 MPa is obtained when 30% coarse aggregates are replaced by soaked pumice aggregates. The percentage increase in the compressive strength is found to be 3.60% as compared to reference concrete when 30% coarse aggregates are replaced by soaked pumice aggregates.
3. Compressive strength of steel fibre reinforced concrete produced by replacing coarse aggregates by unsoaked pumice aggregates goes on increasing up to 30% replacement. Thereafter, compressive strength decreases. A compressive strength of 35.63 MPa is obtained when 30% coarse aggregates are replaced by unsoaked pumice aggregates. The percentage increase in the compressive strength is found to be 7.87% as compared to reference concrete when 30% coarse aggregates are replaced by unsoaked pumice aggregates.
4. It is observed that the compressive strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more as compared to that produced by soaked pumice aggregates. This is true for all percentage replacements of coarse aggregates by pumice aggregates. This is due to the fact that the steel

fibre reinforced concrete which is cured in water gets all recommended ambiance for curing.

5. Tensile strength of steel fiber reinforced concrete with superabsorbent polymer shows an increasing trend as the percentage of superabsorbent polymer in it increases up to 0.3%. A tensile strength of 3.92 MPa is obtained when 0.3% superabsorbent polymer is used. After 0.3% addition of superabsorbent polymer, tensile strength shows a decreasing trend. The percentage increase in the tensile strength is found to be 26.05% when 0.3% of superabsorbent polymer is added as compared to reference concrete.
6. Tensile strength of steel fibre reinforced concrete produced by replacing coarse aggregates by soaked pumice aggregates goes on increasing up to 30% replacement. There after the tensile strength decreases. A tensile strength of 3.61 MPa is obtained when 30% coarse aggregates are replaced by soaked pumice aggregates. The percentage increase in the tensile strength is found to be 16.08% as compared to reference concrete when 30% coarse aggregates are replaced by soaked pumice aggregates.
7. Tensile strength of steel fibre reinforced concrete produced by replacing coarse aggregates by unsoaked pumice aggregates goes on increasing up to 30% replacement. Thereafter, tensile strength decreases. A tensile strength of 3.75 MPa is obtained when 30% coarse aggregates are replaced by unsoaked pumice aggregates. The percentage increase in the tensile strength is found to be 20.58% as compared to reference concrete when 30% coarse aggregates are replaced by unsoaked pumice aggregates.
8. It is observed that the tensile strength of steel fibre reinforced concrete produced by unsoked pumice aggregates is more as compared to that produced by soaked pumice aggregates. This is true for all percentage replacement of coarse aggregates by pumice aggregates. This is due to the fact that the steel fibre reinforced concrete which is cured in water gets all recommended ambiance for curing.
9. Flexural strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend as the percentage of superabsorbent polymer in it increases up to 0.3%. A flexural strength of 6.13 MPa is obtained when 0.3% superabsorbent polymer is used. After 0.3% addition of superabsorbent polymer, flexural strength shows a decreasing trend. The percentage increase in the flexural strength is found to be 13.52% when 0.3% of superabsorbent polymer is added as compared to reference concrete.
10. Flexural strength of steel fibre reinforced concrete produced by replacing coarse aggregates by soaked pumice aggregates goes on increasing up to 30% replacement. There after the flexural strength decreases. A flexural strength of 6.67 MPa is obtained when 30% coarse aggregates are replaced by soaked pumice aggregates. The percentage increase in the flexural strength is found to be 23.52% as compared to reference concrete when 30% coarse aggregates are replaced by soaked pumice aggregates.
11. Flexural strength of steel fibre reinforced concrete produced by replacing coarse aggregates by unsoaked pumice aggregates goes on increasing up to 30% replacement. A flexural strength of 6.80 MPa is obtained when 30% coarse aggregates are replaced by unsoaked pumice aggregates. The percentage increase in the compressive strength is found to be 25.93% as compared to reference concrete when 30% coarse aggregates are replaced by unsoaked pumice aggregates.
12. It is observed that the flexural strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more as compared to that produced by soaked pumice aggregates. This is true for all percentage replacements of coarse aggregates by pumice aggregates. This is due to the fact that the steel fibre reinforced concrete which is cured in

water gets all recommended ambiance for curing.

13. Shear strength of steel fiber reinforced concrete with superabsorbent polymer shows an increasing trend as the percentage of superabsorbent polymer in it increases up to 0.3%. A shear strength of 8.06 MPa is obtained when 0.3% superabsorbent polymer is used. After 0.3% addition of superabsorbent polymer, shear strength shows a decreasing trend. The percentage increase in the shear strength is found to be 24.38% when 0.3% of superabsorbent polymer is added as compared to reference concrete.
14. Shear strength of steel fibre reinforced concrete produced by replacing coarse aggregates by soaked pumice aggregates goes on increasing up to 30% replacement. There after the shear strength decreases. A shear strength of 7.50 MPa is obtained when 30% coarse aggregates are replaced by soaked pumice aggregates. The percentage increase in the shear strength is found to be 15.74% as compared to reference concrete when 30% coarse aggregates are replaced by soaked pumice aggregates.
15. Shear strength of steel fibre reinforced concrete produced by replacing coarse aggregates by unaoaked pumice aggregates goes on increasing up to 30% replacement. A shear strength 7.68 MPa is obtained when 30% coarse aggregates are replaced by unsoaked pumice aggregates. The percentage increase in the shear strength is found to be 18.52% as compared to reference concrete when 30% coarse aggregates are replaced by unsoaked pumice aggregates.
16. It is observed that the shear strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more as compared to that produced by soaked pumice aggregates. This is true for all percentage replacements of coarse aggregates by pumice aggregates. This is due to the fact that the steel fibre reinforced concrete which is cured in water gets all recommended ambiance for curing.
17. Impact strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend as the percentage of superabsorbent polymer in it increases up to 0.3%. An impact strength of 1203.37 N-m for first crack and 1237.95 N-m for final failure is obtained when 0.3% superabsorbent polymer is used. After 0.3% addition of superabsorbent polymer, impact strength shows a decreasing trend. The percentage increase in the impact strength is found to be 33.85% for the first crack and 28.78% for final failure when 0.3% of superabsorbent polymer is added as compared to reference concrete.
18. Impact strength of steel fibre reinforced concrete produced by replacing coarse aggregates by soaked pumice aggregates goes on increasing up to 30% replacement. There after the impact strength decreases. An impact strength of 1141.13 N-m for the first crack and 1244.87 N-m for final failure is obtained when 30% coarse aggregates are replaced by soaked pumice aggregates. The percentage increase in the impact strength for the final failure is found to be 29.50% as compared to reference concrete when 30% coarse aggregates are replaced by soaked pumice aggregates.
19. Impact strength of steel fibre reinforced concrete produced by replacing coarse aggregates by unsoaked pumice aggregates goes on increasing up to 30% replacement. Thereafter, impact strength decreases. A impact strength of 1161.88 N-m for first crack and 1265.62 N-m for final failure is obtained when 30% coarse aggregates are replaced by unsoaked pumice aggregates. The percentage increase in the impact strength for the final failure is found to be 31.66% as compared to reference concrete when 30% coarse aggregates are replaced by unsoaked pumice aggregates.
20. Impact strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more as compared to that

produced by soaked pumice aggregates. This is true for all percentage replacements of coarse aggregates by pumice aggregates. This is due to the fact that the steel fibre reinforced concrete which is cured in water gets all recommended ambiance for curing.

6. Conclusions

- Compressive strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend up to 0.3% addition of superabsorbent polymer. Beyond this percentage the compressive strength will get affected.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by soaked pumice aggregates will yield higher compressive strength.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by unsoaked pumice aggregates yield higher compressive strength.
- Compressive strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more as compared to that produced by soaked pumice aggregates.
- Tensile strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend up to 0.3% addition of superabsorbent polymer. Beyond this percentage the tensile strength will get affected.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by soaked pumice aggregates will yield higher tensile strength.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by unsoaked pumice aggregates will yield higher tensile strength.
- Tensile strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more compared to that produced by soaked pumice aggregates.
- Flexural strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend up to 0.3% addition of superabsorbent polymer. Beyond this percentage the flexural strength will get affected.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by soaked pumice aggregates will yield higher flexural strength.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by unsoaked pumice aggregates will yield higher flexural strength.
- Flexural strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more compared to that produced by soaked pumice aggregates.
- Shear strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend up to 0.3% addition of superabsorbent polymer. Beyond this percentage the shear strength will get affected.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by soaked pumice aggregates will yield higher shear strength.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by unsoaked pumice aggregates will yield higher shear strength.
- Shear strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more compared to that produced by soaked pumice aggregates.
- Impact strength of steel fiber reinforced concrete with superabsorbent polymer show an increasing trend up to 0.3% addition of superabsorbent polymer. Beyond this percentage the shear strength will get affected.
- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by

soaked pumice aggregates will yield higher impact strength.

- Steel fibre reinforced concrete produced with 30% replacement of coarse aggregates by unsoaked pumice aggregates will yield higher impact strength.
- Impact strength of steel fibre reinforced concrete produced by unsoaked pumice aggregates is more compared to that produced by soaked pumice aggregates.

Acknowledgements.

The authors are very much thankful to Hon'ble Vice-Chancellor, Registrar, Registrar (Evaluation) and all other concerned authorities of Visvesvaraya Technological University, Belagavi for encouraging the work.

The authors also thank the Commissioner of Collegiate and Technical Education and Director of Technical Education for their support. Thanks are also due to Dr. J. G. Kori, Professor and Head, Civil Engineering Department, GEC, Haveri and other colleagues for their moral courage.

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