RESEARCH ARTICLE OPEN ACCESS

Experimental Investigation on Flexural Behaviour of Fibre Reinforced Metakaolin Concrete and Steel Fibre Reinforced Concrete

Khalid Hussain [1], Hemant Kumar Sain [2], Shruti Bhargava [3]

[1] M.Tech Scholar, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur
[2] , [3]Assistant Professor, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur

ABSTRACT - Utilization of steel fibers is known to enhance the flexural strength in concrete beams, but the focus of the present study is to investigate experimentally the flexural behavior of the beam section with steel fibers and Metakaolin. Combination of both known as FRMC (Fiber Reinforced Metakaolin Concrete). The focus of the present study to show the variation in flexural strength in SFRC and FRMC. The specimen was prepared with M 40 grade of concrete, with or without Metakaolin. The percentage of Metakaoline used only 10% as a replacement of Cement used. In the present study, there is a variation of fiber depth which is measured from the bottom are taken into consideration which is 0.25d to the full depth of the beam with the difference of 0.25d Beam specimen of 100*100*500 mm were casted and tested respectively for flexural strength at the age of 28 days.

Keywords: SFRC, Steel Fiber, Metakaolin, FRMC, M 40, Flexural Strength Test.

I. INTRODUCTION

Some investigations suggest use of steel fibers only in zone, where tensile stresses are induced in a manner similar to that presently contemplated and used in conventional reinforced concrete. The inclusion of fibers into a matrix over only a partial thickness of the beam is regarded as partially fiber reinforcing a beam [5]. The present study deals with partially steel fiber reinforced M 40 grade of Concrete beams, the FRC in the present study consisted of OPC and OPC with Metakaolin. The present study aimed to evaluate the performance of flexural member with steel fiber and with or without Metakaolin [6].

II. MATERIALS AND METHODOLOGY

2.1 Steel fiber reinforced concrete (SFRC) is a composite material whose segments incorporate the conventional constituents of Portland concrete cement (hydraulic cement, fine and coarse aggregates, admixtures) and a scattering of haphazardly arranged short discrete steel fibers. Similarly likewise with all FRC materials, contrasted with plain concrete, the most observable contrasts are improved ductility and post cracking performance.

2.2 Steel Fiber – In the experiment–Dramixgluedsteelfiberwereused.Thesteelfibercontentwasvariedas 0%, 0.5%, 1.0%, and 1.5% by weight of cement. The steel fibers were 60mm in length, and the aspect ratio of the fiber was80.

2.3 Metakaolin – Metakaolin isn't a byproduct. It's obtained by claiming pure or refined mineral clay at a temperature of 6500 to 8500 ° C so grinding to a fineness of 700 to 900 m two / weight unit. Metakaolin could be a pozzolanic supplement/product that has several specific properties. Metakaolin is obtainable in many alternative varieties and qualities.

IS Code 516: 1959 used for the method of tests for the flexural strength of concrete. The size of the beam 500mm x 100mm x 100mm used in the present study . The specimens were tested after deep curing for 28 days.

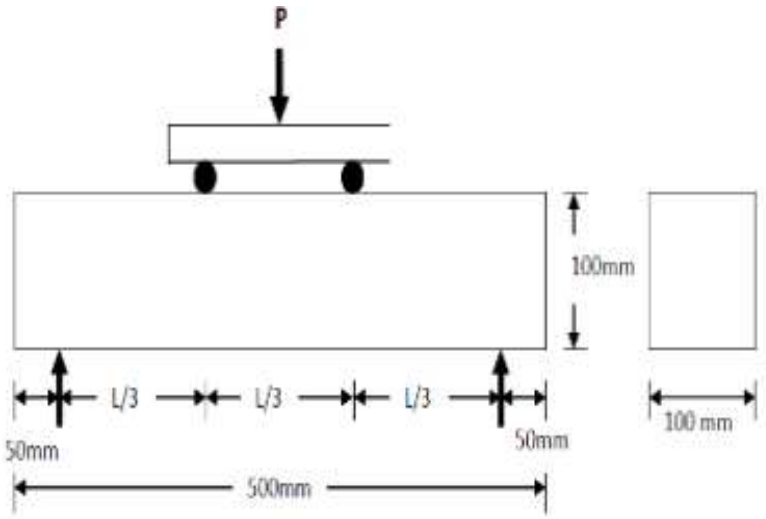


Fig 1: Two Point Loading Setup in flexure test

III. RESULTS AND DISCUSSIONS

Flexural Strength test results –

3.1 The flexural strength and deflection test results of beam specimens with Metakaolin and 0.5% fiber content at 28 days age are presented in Table 1

Table 1: Flexural Strength and Deflection of Concrete Mixes with 0.5 % Fiber Content, 10% MK, and Variation of Fiber Depth (at the age of 28 days)

Specimen	**Fiber Depth**	**Deflection**	**Flexural Strength**
Cement + Metakaolin	**Measured from bottom**	**(mm)**	**(N/mm^2)**
90+10	25	0.022	6.3
90+10	50	0.039	6.64
90+10	75	0.050	6.83
90+10	100	0.060	7.16

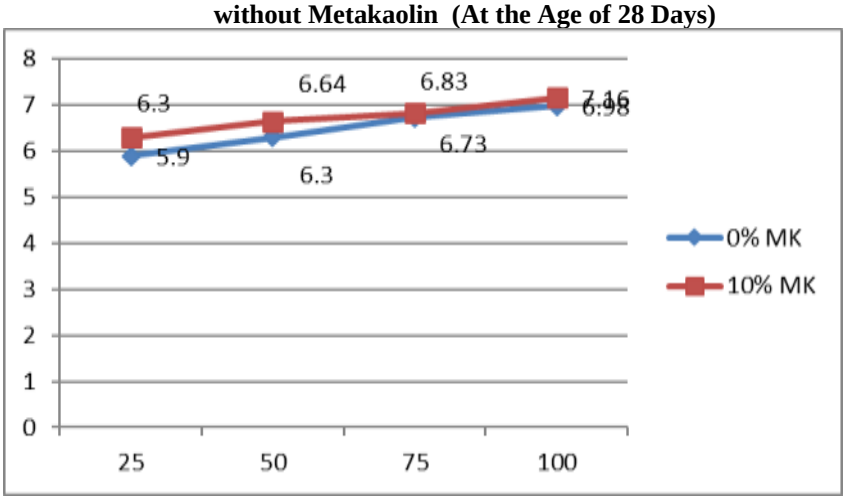
3.2 The flexural strength and deflection test results of beam specimens without Metakaolin and 0.5% fiber content at 28 days age are presented in Table 2.

Table 2: Flexural Strength and Deflection of Concrete Mixes with 0.5 % Fiber Content and Variation of Fiber Depth (at the age of 28 days)

Specimen	**Fiber Depth**	**Deflection**	**Flexural Strength**
Cement + Metakaolin	**Measured from bottom**	**(mm)**	**(N/mm^2)**
100 + 0	25	0.018	5.9
100 + 0	50	0.036	6.3

100 + 0	75	0.047	6.73
100 + 0	100	0.051	6.98

Figure 2 : Variations in Flexural Strength with 0.5% Fiber Content at various depth and with or without Metakaolin (At the Age of 28 Days)



3.3 The flexural strength and deflection test results of beam specimens with Metakaolin and 1% fiber content at 28 days age are presented in Table 3

Table 3: Flexural Strength and Deflection of Concrete Mixes with 1 % Fiber Content, 10% MK, and Variation of Fiber Depth (at the age of 28 days)

Specimen	**Fiber Depth**	**Deflection**	**Flexural Strength**
Cement + Metakaolin	**Measured from bottom**	**(mm)**	**(N/mm^2)**
90+10	25	0.037	6.65
90+10	50	0.045	6.83
90+10	75	0.053	7.01
90+10	100	0.072	7.28

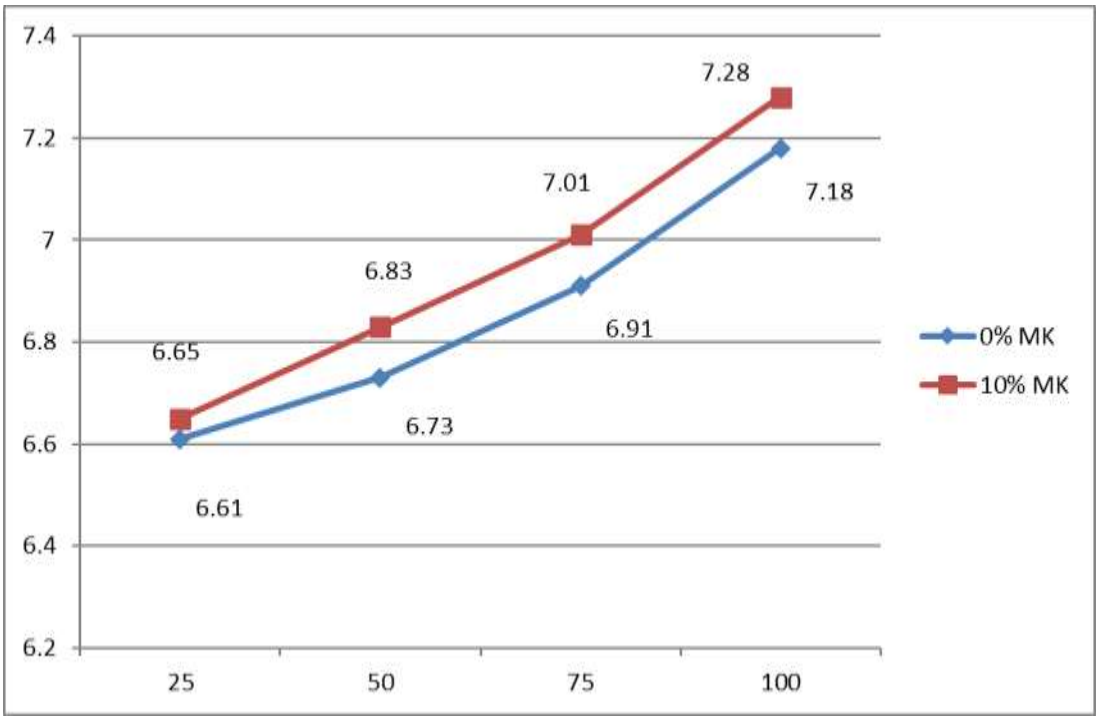
3.4 The flexural strength and deflection test results of beam specimens without Metakaolin and 1% fiber content at 28 days age are presented in Table 4.

Table 4 : Flexural Strength and Deflection of Concrete Mixes with 1 % Fiber Content and Variation of Fiber Depth (at the age of 28 days)

Specimen	**Fiber Depth**	**Deflection**	**Flexural Strength**
Cement + Metakaolin	**Measured from bottom**	**(mm)**	**(N/mm^2)**
100 + 0	25	0.034	6.61
100 + 0	50	0.041	6.73
100 + 0	75	0.052	6.91

100 + 0	100	0.057	7.18

Figure 3: Variations in Deflection with 1% Fiber Content at various depth and with or without Metakaolin (At the Age of 28 Days)



3.5. The flexural strength and deflection test results of beam specimens with Metakaolin and 1.5 % fiber content at 28 days age are presented in Table 5

Table 5: Flexural Strength and Deflection of Concrete Mixes with 1.5 % Fiber Content, 10% MK and Variation of Fiber Depth (at the age of 28 days)

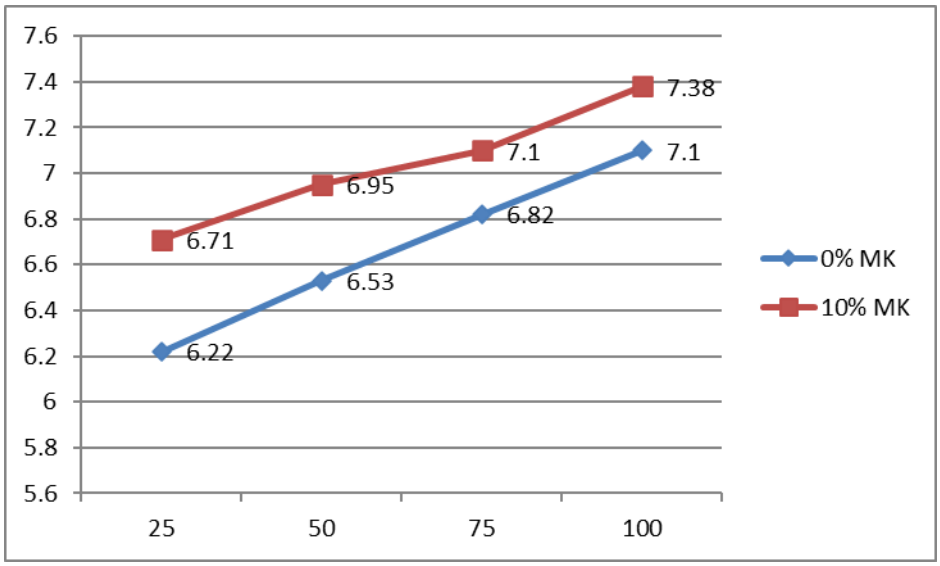
Specimen	**Fiber Depth**	**Deflection**	**Flexural Strength**
Cement + Metakaolin	**Measured from bottom**	**(mm)**	**(N/mm^2)**
90+10	25	0.050	6.71
90+10	50	0.060	6.95
90+10	75	0.072	7.1
90+10	100	0.088	7.38

3.6 The flexural strength and deflection test results of beam specimens without Metakaolin and 1.5 % fiber content at 28 days age are presented in Table 6.

Table 6: Flexural Strength and Deflection of Concrete Mixes with 1.5 % Fiber Content and Variation of Fiber Depth (at the age of 28 days)

Specimen	Fiber Depth	Deflection	Flexural Strength
Cement + Metakaolin	Measured from bottom	(mm)	(N/mm^2)
100 + 0	25	0.047	6.22
100 + 0	50	0.059	6.53
100 + 0	75	0.067	6.82
100 + 0	100	0.079	7.1

Figure 4: Variations in Flexural Strength with 1.5 % Fiber Content at various depth and with or without Metakaolin (At the Age of 28 Days)



3.7 Variation in flexural strength with respect to different fibers content

3.7.1 The flexural strength test results of beam specimens with Metakaolin and 0.5%, 1% and 1.5% fiber content at 28 days age are presented in Table 7 and figure 5..

Table 7: Flexural Strength of Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content, 10% MK and Variation of Fiber Depth (at the age of 28 days)

Specimen	Fiber Depth	Flexural Strength		
Cement + Metakaolin	Measured from bottom	0.5% SF	1% SF	1.5% SF
90+10	25	6.3	6.65	6.71
90+10	50	6.64	6.83	6.95
90+10	75	6.83	7.01	7.1
90+10	100	7.16	7.28	7.38

Figure 5: Flexural Strength of Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content, 10% MK and Variation of Fiber Depth (at the age of 28 days)

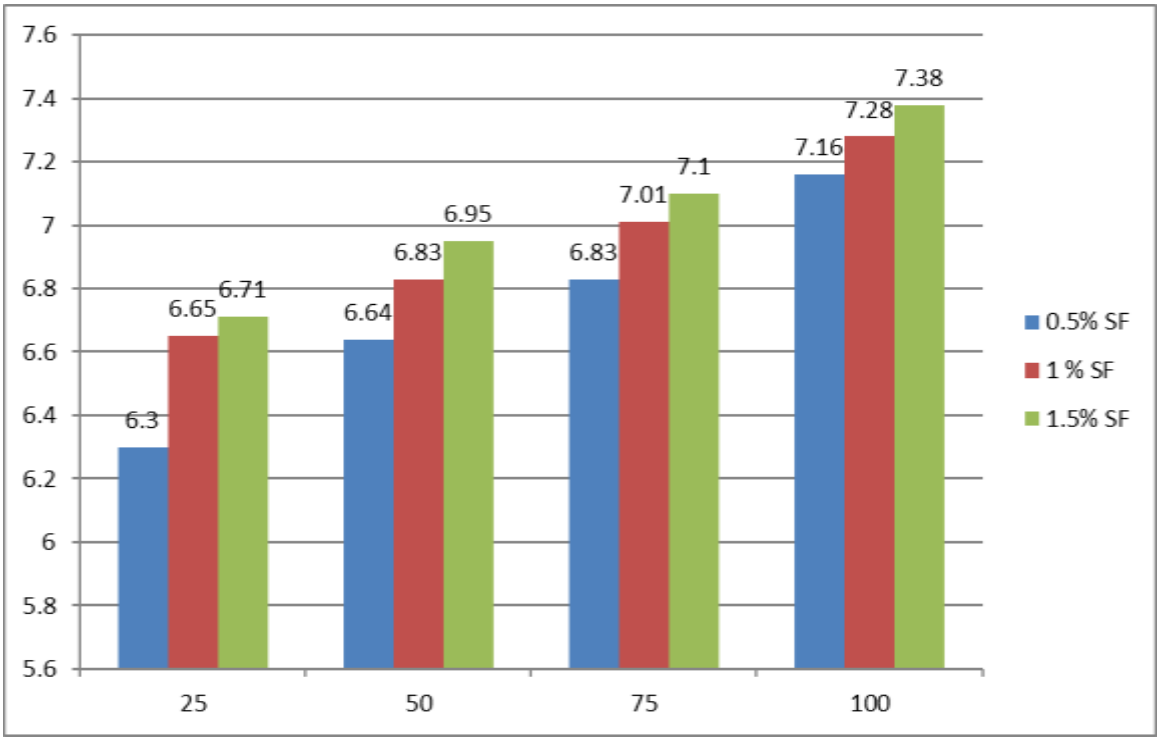


Figure 4 represents the variation of flexural strength at the age of 28 days and Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content, 10% MK and Variation of Fiber Depth 25mm, 50mm, 75mm and full depth of beam.

3.7.2 The flexural strength test results of beam specimens with Metakaolin and 0.5%, 1% and 1.5% fiber content at 28 days age are presented in Table 8 and figure 6.

Table 8: Flexural Strength of Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content and Variation of Fiber Depth (at the age of 28 days)

Specimen	**Fiber Depth**	**Flexural Strength**		
Cement + Metakaolin	**Measured from bottom**	**0.5% SF**	**1% SF**	**1.5% SF**
100+0	25	5.9	6.61	6.22
100+0	50	6.3	6.73	6.53
100+0	75	6.73	6.91	6.82
100+0	100	6.98	7.18	7.1

Figure 6: Flexural Strength of Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content and Variation of Fiber Depth (at the age of 28 days)

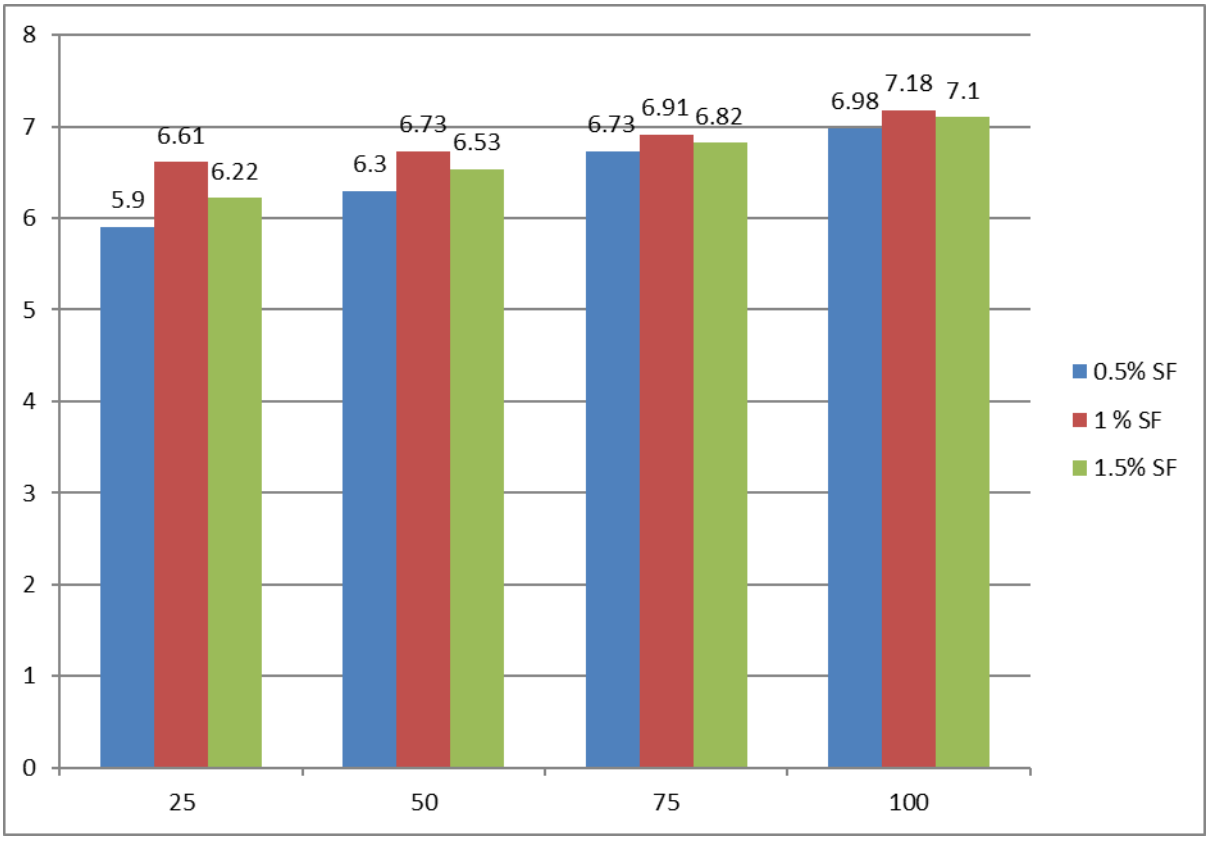


Figure 6 represents the variation of flexural strength at the age of 28 days and Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content without Mk and Variation of Fiber Depth 25mm, 50mm, 75mm and full depth of beam.

IV. CONCLUSIONS

1. For the hardened properties of Fiber Reinforced Metakaolin Concrete, the steel fiber and Metakaolin combination enhance the flexural strength.
2. On increasing depth of the FRC, with 1% and 1.5 % fiber content, the rate of gain in flexural strength increases as well.
3. Above results show that the advantage of adding fiber is more when the volume fraction is 1% or more, both for the flexural strength and deflection.

REFERENCES

1. Gunasekaran, M., "The strength and behavior of light weight concrete beams made with fly-ash aggregates and fiber-reinforced partially", Indian Concr. J., Thane, Mumbai, India, pp- 332–334, 1975.
2. Snyder, M. J., and Lankard, D. R., "Factors Affecting the Flexural Strength of Steel Fibrous Concretes," Proceedings, American Concrete Institute, Vol. 69, pp. 96-101, 1972.
3. Batson, G., Jenkins, E., and Spatney, R., "Steel Fibers as Shear Reinforcement in Beams," Proceedings, American Concrete Institute, Vol. 69, No. 10, pp. 640-644, 1972.
4. Sunny and Mohan (2017) , "Effect of Metakaolin on the properties of Concrete" International Research Journal of Engineering & Technology Volume 4, Issue 7, 2017.
5. Mehtab Alam, Hemant Kumar Sain, "Partial Replacement of Cement with Kota Stone Slurry Powder and Coal Ash in High Performance Concrete", Design Engineering, pp. 1094-1102, 2021
6. P. Dinkar, Pradosh K. Sahoo, and G. Sriram, "Effect of Metakaolin Content on the Properties of High Strength Concrete", International Journal of Concrete Structures and Materials Vol.7, No.3, pp.215–223, 2013.

7. Girija Vidnyan Gaikwad and Dr.Y. M. Ghugal," Experimental Investigation on Metakaolin Modified Fiber Reinforced Concrete", International Research Journal of Engineering and Technology (IRJET), Volume-06, Issue-08, pp-39-44, Aug 2019.
8. Mehtab Alam and Hemant Kumar Sain, "An Experimental Study on Partial Replacement of Cement with Kota Stone Slurry Powder and Coal Ash in High Performance Concrete", International Journal of Engineering Trends and Applications (IJETA), Volume-8, 2021.
9. Rohit Kumar Tailor, Hement Kumar Sain, "Effect of carbon and glass fibre on compressive strength, split tensile strength and flexural strength of SCC", International Journal of Engineering Research and Generic Science (IJERGS), Vol-7, Issue-5, PP. 7-12, September October 2021.
10. Sarjeet Singh Yadav, Hemant Kumar Sain,"Utilization of Sugarcane Bagasse ash in Concrete as Partial Replacement of Cement", International Journal of Engineering Research and Generic Science (IJERGS), Vol-5, Issue-2, PP. 73-78, March April 2019.