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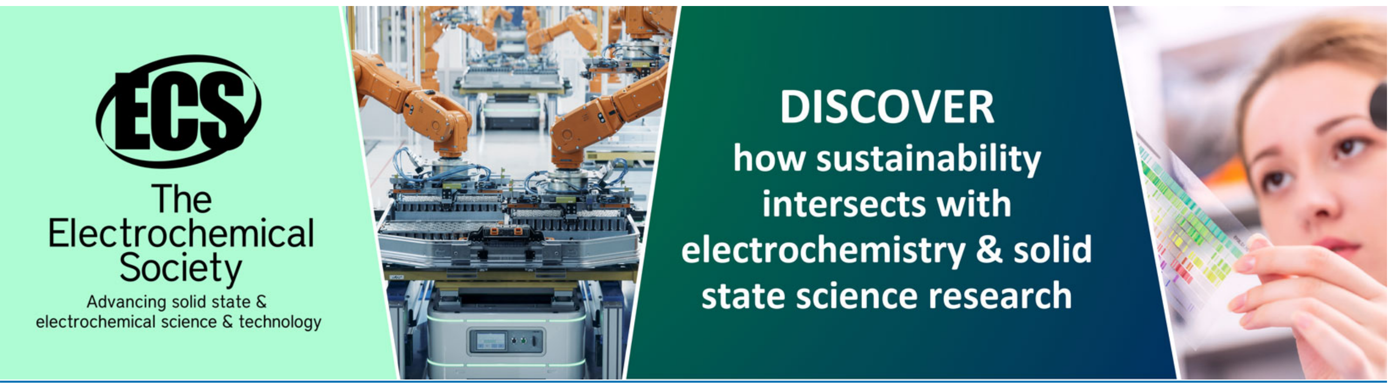

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Retraction

Retraction: Investigation on Properties of Concrete by adding Metakaolin and Kenaf Fibres (*IOP Conf. Ser.: Mater. Sci. Eng.* **1145** 012009)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Investigation on Properties of Concrete by adding Metakaolin and Kenaf Fibres

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Abstract. Ordinary Portland cement manufacturing can be affected to over 5 per cent of global CO_2 emissions a demand for cement continues to rise. The architecture sector led planners and architects to look for alternate cemented materials for potential use in concrete buildings. Such natural admixtures like metakaolin and kenaf fibres can be used to alter pozzolanic behaviour and mechanical properties in concrete. The chemicals used by the SCM in construction to replace cement such as metakaolin not only minimize carbon dioxide emissions, but also greatly increase workability and longevity. The metakaolin is replaced with cement in 5%,10%,15% and 20% by its weight. The Kenaf fibre is added in concrete about 0.5% and 1% by the volume fraction of cement.

Keywords: Metakaolin, Kenaf fibre, Concrete, optimum percentage of replacement.

1. Introduction

Because of its flexibility and affordability concrete is the one of the materials used in construction worldwide. When compared to other construction material, Concrete is easy to erect and construct with lower cost. The proper compliance to reinforcing bars and concrete is the most desirable property since reinforced concrete product structural efficiency relies on monolithic behaviour [1]. The prominent aspect regulating the bond's competency is mainly the concrete consistency. Also, because reinforcing steel bars are obtained from a fixed production process, and the properties do not fluctuate noticeably compared to concrete [2]. Structural concretes however have many different characteristics depending mainly on the quantity and ingredients of materials. It is reported that steel reinforcement has superior adherence to concrete with improved mechanical property [3]. Besides its excellent properties, when subjected to tensile stress concrete shows a rather low performance. The main use of fibres is to improve tensile strength of concrete behaviour and attracted researcher's interest [4].

Enormous development taking place in the last past centuries and culture was impossible to satisfy demands in the building industry in terms of world's material and energy supplies [5]. Continued population growth and accelerated industrialization resulted with global urbanization. In the year 1804 world population hit the first one billion; and it took only 12 years to rise from 5 to 6 billion. The world's population is now expected to grow from 6 billion today to 8 billion by 2036 and 9.3 billion by 2050. More than 95 percent of this rise will occur in developed countries around the world.

Reinforced Concrete with fibres has wide characteristics and mechanical properties to control the cracks [6]. Fibre reinforced concrete (FRC) has tendency to withstand loads and satisfied for deflection. FRC performance depending on the matrix properties, kenaf fibre material, fibre concentration, fibre geometry, fibre orientation, and fibre allocation [7].

Researchers have used pozzolanic materials for many years to improve the mechanical properties, especially compressive strength of concrete [8]. For production of high strength concrete, Metakaolin is one of the most known mineral admixtures.

2. Materials and Properties

The materials used for research work for preparing the concrete will be cement, fine aggregate, coarse aggregate, water, kenaf fibre and metakaolin [9].

2.1. Cement

The cement is a substance which is used as a binding agent in concrete. Cement used for this investigation is ordinary Portland cement OPC 53, the physical and chemical properties are tabulated below in Table 1.

Table 1. Physical Properties of Cement

Physical Properties	Results
Color	Grey
Specific gravity	3.14
Surface area(cm^2/gm)	2250
Physical state	Solid
Microns	<90
Volume Expansion	3 mm
Consistency	28.3%
Setting time (Initial)	155 minutes
Setting time (Final)	355 minutes
Compressive strength	56.75 N/mm^2 (28days)

2.2. Fine aggregate

Available local river sand confirming to zone II as per IS 383:1970 is cleaned, sieved and used. The properties of river sand are shown in Table 2.

Table 2. Physical Properties of River Sand

Physical Properties	Results
Appearance	Grainy

Specific Gravity	2.72
Bulk Density	2.7 g/cc
Water Absorption	2.3%
Moisture Content	1.3%
Zone	II
Colour	White
Fineness Modulus	1.4
Maximum Grain Size	1.18

2.3. *Metakaolin*

Metakaolin is generated at a temperature of 600-800 degrees Celsius by heating kaolin by calcination process [10]. Metakaolin is the available natural mineral commonly used small, white clay stone. It is consistent in nature, white appearance, and leads to durability. It reacts quickly with the calcium hydroxide in the cement paste, converting it into stable cementation compounds, refining concrete's microstructure by reducing its permeation properties [11]. Since it is light color it gives an aesthetic advantage, the physical and chemical properties are tabulated below in Table 3 and Table 4.

Table 3. Physical Properties of Micro Silica

Physical Properties of Micro silica	Results
Specific gravity	2.5
Surface area(cm^2/gm)	5300
Physical state	Solid
Micron size	< 20

Table 4. Chemical Properties of Micro Silica

Chemical Properties	Results (%)
SiO_2	51.6
Al_2O_3	41.3
Fe_2O_3	0.64
CaO	0.52
MgO	0.16

2.4. *Coarse aggregate*

Locally available coarse aggregate is used with specific gravity of 2.8 and aggregate size of 20mm with water absorption of 0.3%.

2.5. Water
Ordinary Portable water is used for mixing and curing confirming to IS 456 -2000 which is free from salt.

2.6. Kenaf Fibre
In this study the specimens were treated with chemical treatment. The fibres were treated with 6% sodium hydroxide (NaOH) for one day [12]. The concentration of sodium hydroxide influences the composites' thermo-physical properties [13]. The fibres were thoroughly washed with fresh water after the treatment and allowed to dry at a high temperature of 100°C.

3. Experimental Investigation
This experiment deals with the various mix proportion adopted for Control concrete [14]. The experimental work is carried out for various materials and for different properties. Casting and Testing of specimens are explained in detail below.

3.1. Mix proportion
The mix proportion of concrete is calculated after analysing the physical properties of each material [15]. The proportion is calculated using IS 10262:2009 code for M25 grade. The mix ratio is tabulated below in Table 5. Various materials in % are tabulated below in Table 6.

Table 5. Mix Ratio

C	FA	CA	W
435	563	1173	203.5
1	1.5	2.69	0.46

Table 6. Various materials in %

Mix ratio	Materials in %
M1	CONVENTIONAL CONCRETE
M2	95 OPC% + 5 MK% + 0.5% KF
M3	90 OPC% + 10 MK% + 0.5% KF
M4	85 OPC% + 15 MK% + 0.5% KF
M5	80 OPC% + 20 MK% + 0.5% KF
M6	95 OPC% + 5 MK% + 1% KF
M7	90 OPC% + 10 MK% + 1% KF
M8	85 OPC% + 15 MK% + 1% KF
M9	80 OPC% + 20 MK% + 1% KF
M10	95 OPC% + 5 MK% + 1.5% KF
M11	90 OPC% + 10 MK% + 1.5% KF
M12	85 OPC% + 15 MK% + 1.5% KF
M13	80 OPC% + 20 MK% + 1.5% KF
M14	95 OPC% + 5 MK% + 2% KF
M15	90 OPC% + 10 MK% + 2% KF
M16	85 OPC% + 15 MK% + 2% KF
M17	80 OPC% + 20 MK% + 2% KF

3.2. Strength Analysis
The strength of hardened concrete is identified by many tests like compression test, tension test and flexural test [16].

3.2.1 Compressive Strength Test. Concrete cubes of size 150mm (Conventional Concrete) was prepared for Compression strength test. The sample is then tested in Universal Testing Machine and the compressive strength is identified and tabulated in Table 7 and shown in Figure 1.

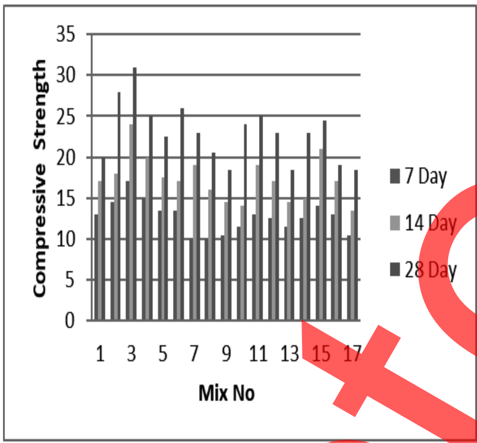

Figure 1. Compression Strength result graph

Table 7. Compression Strength Test

Mix ratio	Compressive Test in N/mm^2		
	7 Days	14 Days	28 Days
M1	13	17	23
M2	14.5	18	28
M3	17	24	31
M4	15	20	25
M5	13.5	17.5	22.5
M6	13.5	17	26
M7	10	19	23
M8	10	16	20.5
M9	10.5	14.5	18.5
M10	11.5	14	24
M11	13	19	25
M12	12.5	17	23
M13	11.5	14.5	18.5
M14	12.5	15	23
M15	14	21	24.5
M16	13	17	19
M17	10.5	13.5	18.5

3.2.2 Split tensile test. Cylinder of size 150mm diameter and 200 mm length (conventional concrete) was prepared for split tensile test [17]. The sample is then tested in Universal Testing Machine and the split tensile strength is identified and tabulated in Table 8 and shown in Figure 2

Table 8. Spit Tensile Strength Test

Mix ratio	Tensile Strength in N/mm^2		
	7 Days	14 Days	28 Days

M1	1.6	1.9	2.45
M2	1.4	1.6	2.35
M3	1.8	2.1	2.68
M4	1.4	1.6	2.45
M5	1.2	1.4	2.35
M6	1.1	1.25	2.10
M7	1.8	2.1	2.68
M8	1.3	1.4	2.25
M9	1.1	1.3	2.05
M10	1.3	1.3	2.15
M11	1.8	2.1	2.55
M12	1.4	1.6	2.25
M13	0.9	1.1	2.05
M14	1.3	1.6	2.35
M15	0.8	1.13	2.45
M16	1.2	1.4	2.05
M17	1.3	1.55	2.15

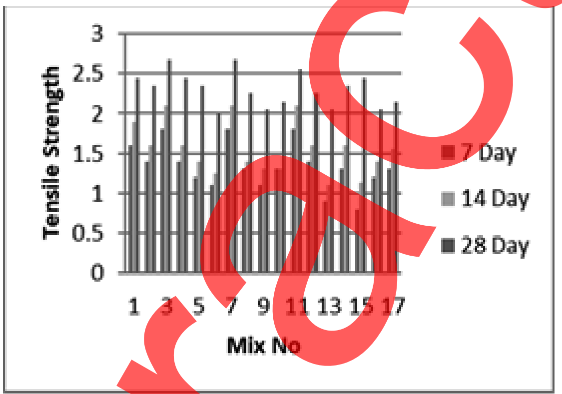

Figure 2. Split tensile strength graph

3.2.3 Flexural strength test. Beams were casted with dimension of 100mm X 100mm x 500mm [18]. Flexural Strength was calculated for 7, 14 and 28 days, Flexural strength for various Mix is tabulated in Table 9 and shown in Figure 3.

Table 9. Flexural strength for various Mix

Mix Ratio	**Flexural Strength in N/mm^2**		
	7 Days	**14 Days**	**28 Days**
M1	5	6	6.5
M2	4.6	5.8	6.2
M3	5.3	6.3	6.8
M4	5	6.1	6.5
M5	4.4	5.8	6
M6	4.4	5.3	6.2
M7	4.8	5.8	6.3
M8	5.0	6.0	6.2
M9	4.3	5.3	5.8
M10	4.2	5.3	5.4

M11	5.1	5.5	5.8
M12	5	5.3	5.6
M13	4.3	5.8	6
M14	4.6	5.9	6.3
M15	5.1	5.8	6.4
M16	5	6.2	6.6
M17	4.4	5.5	5.9

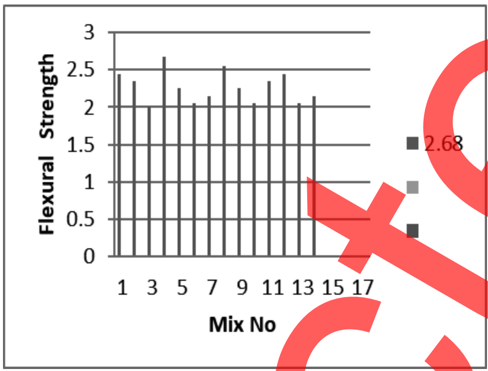

Figure 3. Flexural strength graph

3.2.4 Flexural strength of RCC Beam. Beams were casted with width of 230 mm x 230 mm and length of 1000mm [19]. However, for the first series of beam, the depth of beam considered was 120 mm, and for the second series of the beam, was 100 mm [20]. The beam depth in the second series was reduced by 17% and was designed to fail in shear. A total of two beams were casted for each mixture in both series and tested under four-point bending test [21]. The loading arrangement on the beam is given in Figure 4 and Figure 5 for two mix M1 and M3. Table 10 shows the Cracking Pattern of Beam readings.

Figure 4. Cracking Pattern of Beam (Mix M1)

Figure 5. Cracking Pattern 90 OPC% + 10 MK% + 0.5% KF (Mix M3)

Table 10. Cracking Pattern of Beam readings

Mix Ratio	Py	Δy	Pu	Δu	Pmax (kN)	δmax	μ= δu /

	(kN)	(mm)	(kN)	(mm)		(mm)	δy
M1	43.53	8.1	49	15	57	12.46	1.96
M3	51.30	8.9	50	18	59	11.88	2.02

4. Conclusion

Pozzolanic material is easily available material and are very good supplementary cementitious material as metakaolin hence it can be added instead of cement.

- Up to 10% replacement of cement with Metakaolin gives higher strength than normal concrete at 28 days.
- By Replacing cement with and 10% metakaolin, 5% kenaf fibres gives the compressive strength 50% tension strength 8.3%, flexural strength 9.3%more than the reference mix for 28 days respectively. Out of all pozzolanic material metakaolin gives highest strength in Compression after 28 days.
- By using metakaolin we can make environment more sustainable and reduce Co2 emission in producing of cement.

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